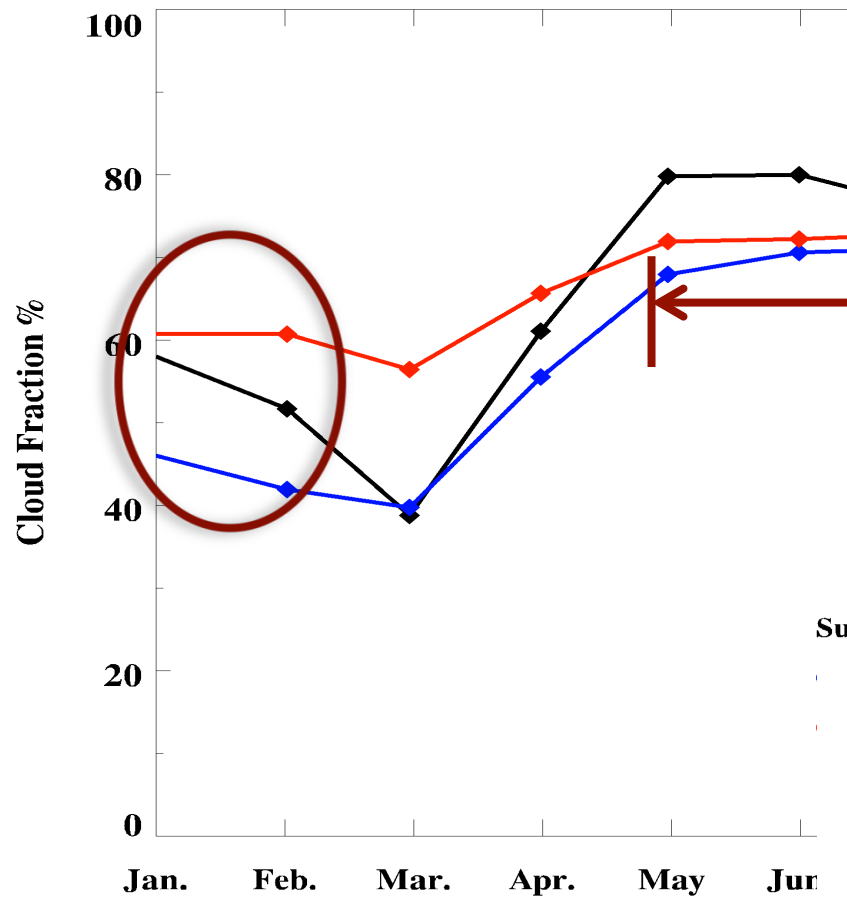


# **Validation of CERES-MODIS Ed4 and Ed2 derived cloud fractions during Polar night using ARM NSA data**

Shaoyue Qiu, Baike Xi, and Xiquan Dong  
University of North Dakota  
Pat Minnis and Sunny Sun-Mack, NASA LaRC



## Climate Mean (2000-2003) CI



## Monthly variations of cloud fraction at Barrow, Alaska

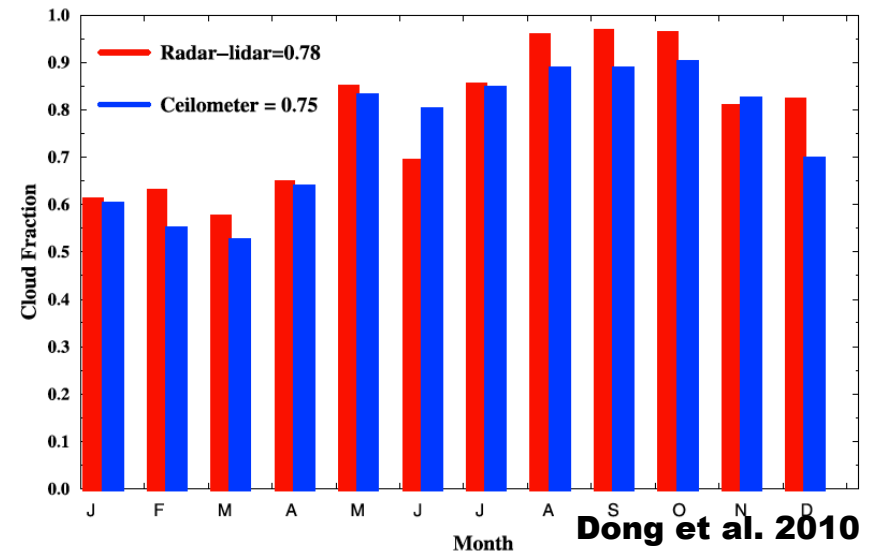


Figure 1. Monthly means of cloud fractions derived from ARM NSA radar-lidar measurements during the period 1999–2004 and ARM NSA ceilometer measurements during the period of June 1998 to May 2008.

Su

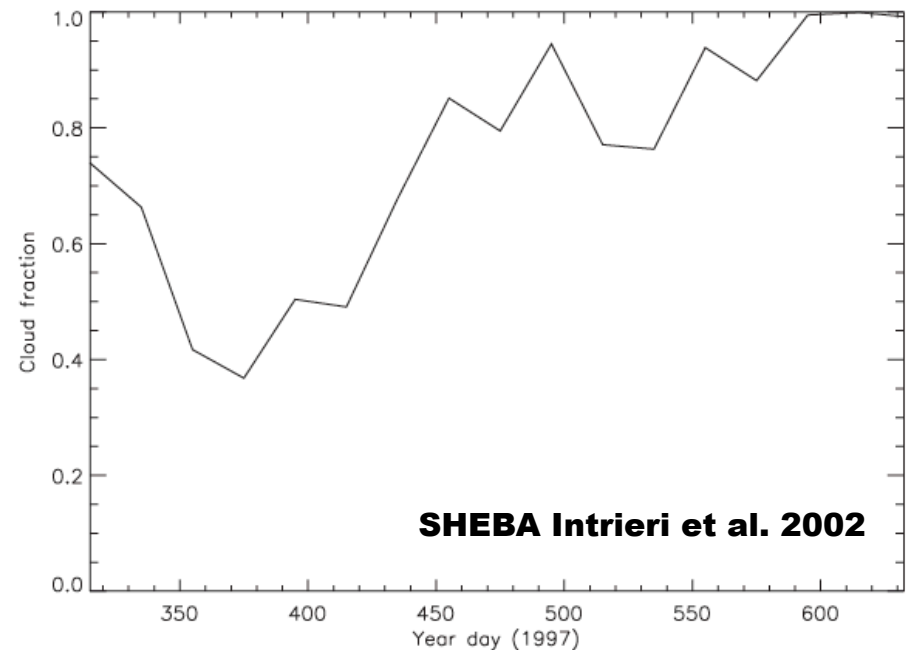


Figure 3. Annual cycle of cloud fraction averaged over 20-day blocks.

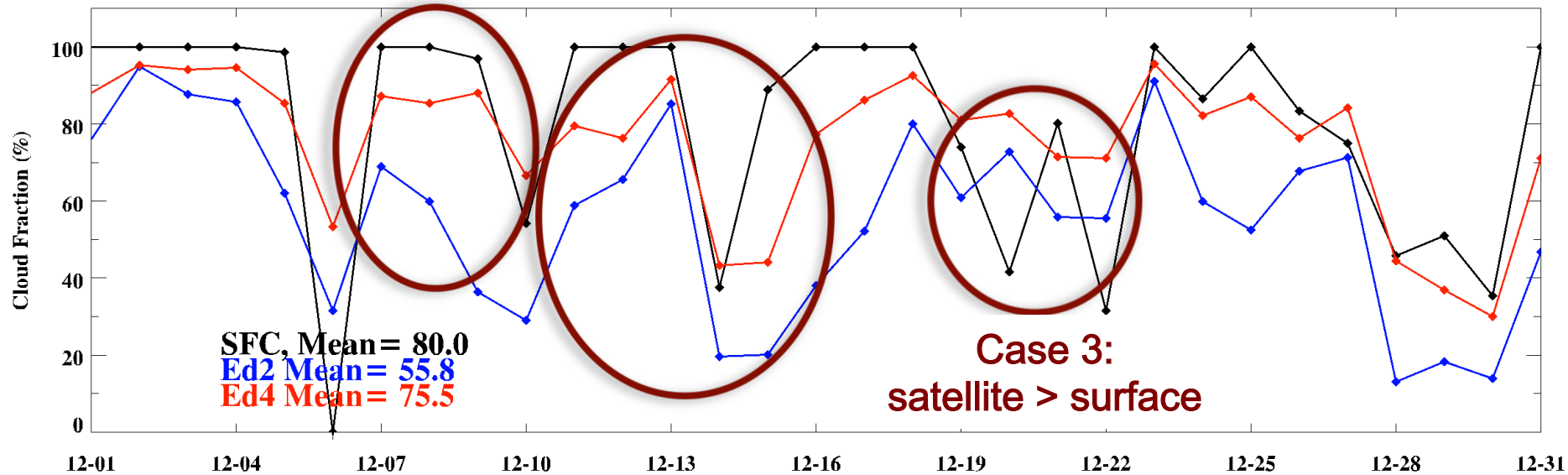
Annually averaged **Ed4** CF is the s **Ed2**.

During summer-fall, **Ed4** and **Ed2** **ARM** ceilometer derived CFs.

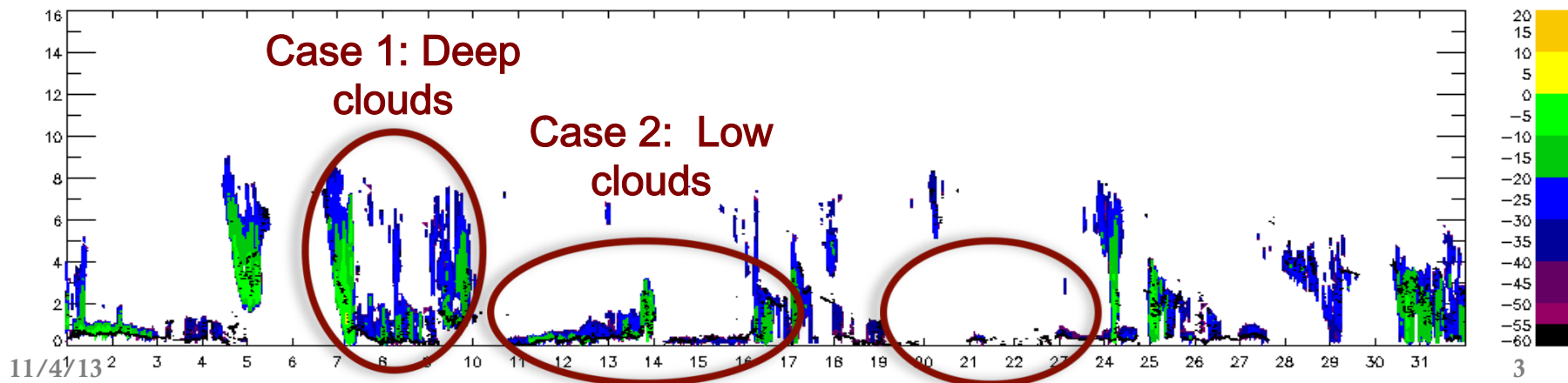
During winter months, **Ed4** CFs a

# Investigating CFs for December 2002

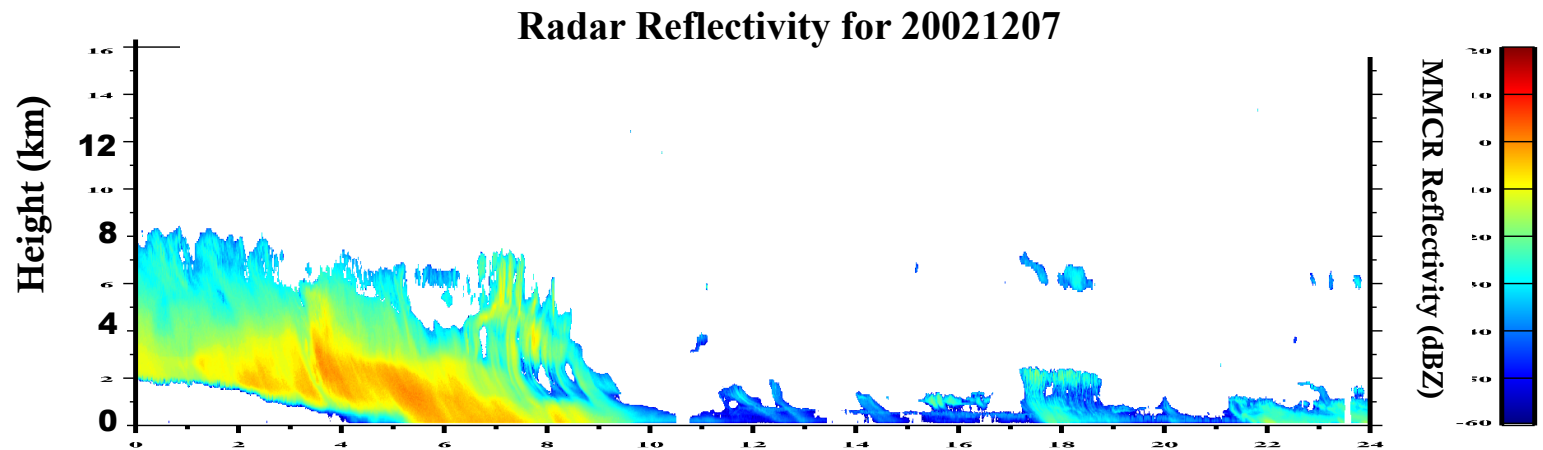
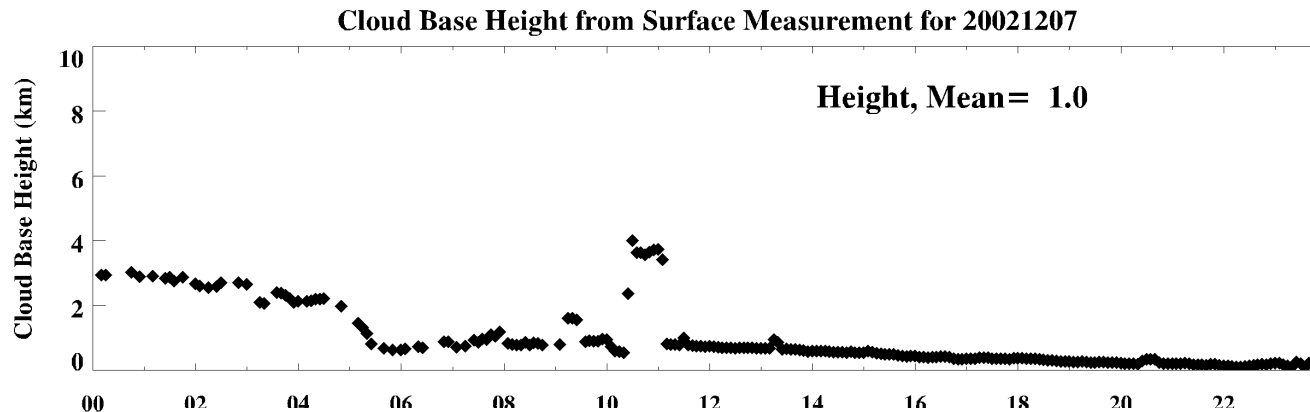
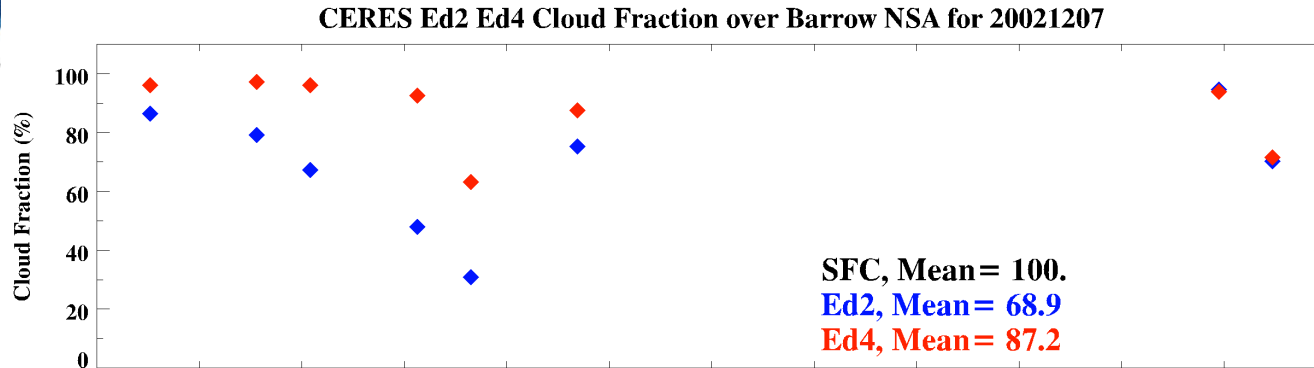
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200212



Radar Reflectivity from Surface Measurement for 200212

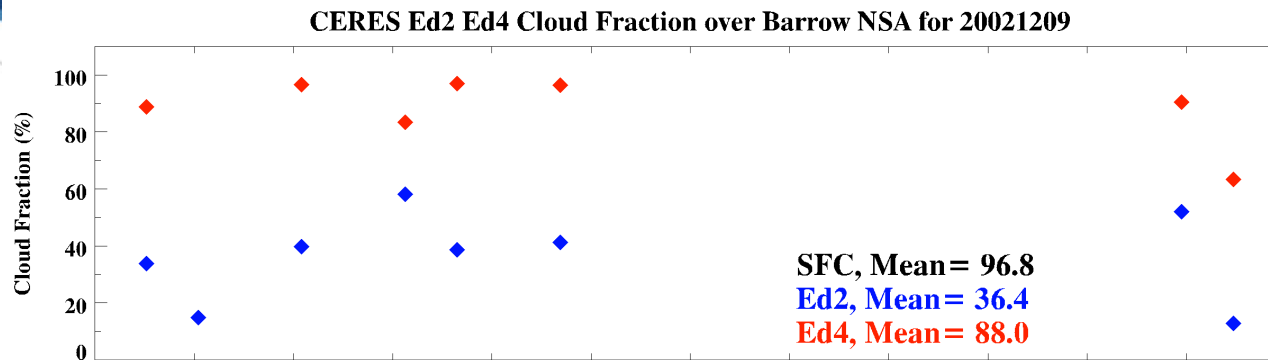


# Case 1: Deep clouds, Dec. 7th, 2002



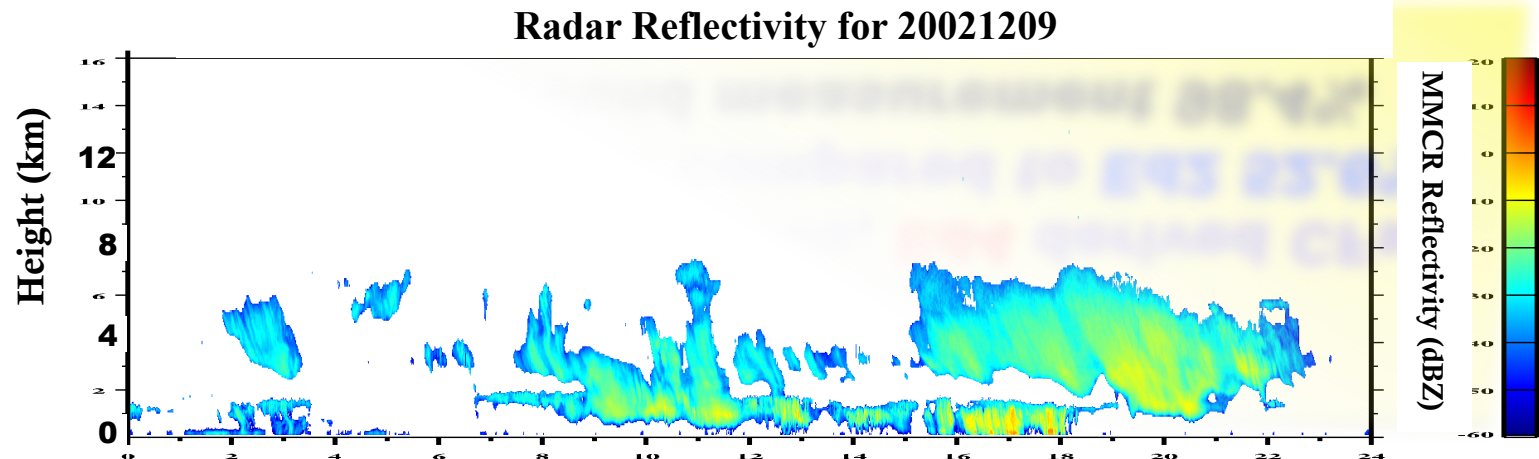


# Case 1: Deep clouds, Dec. 9th, 2002



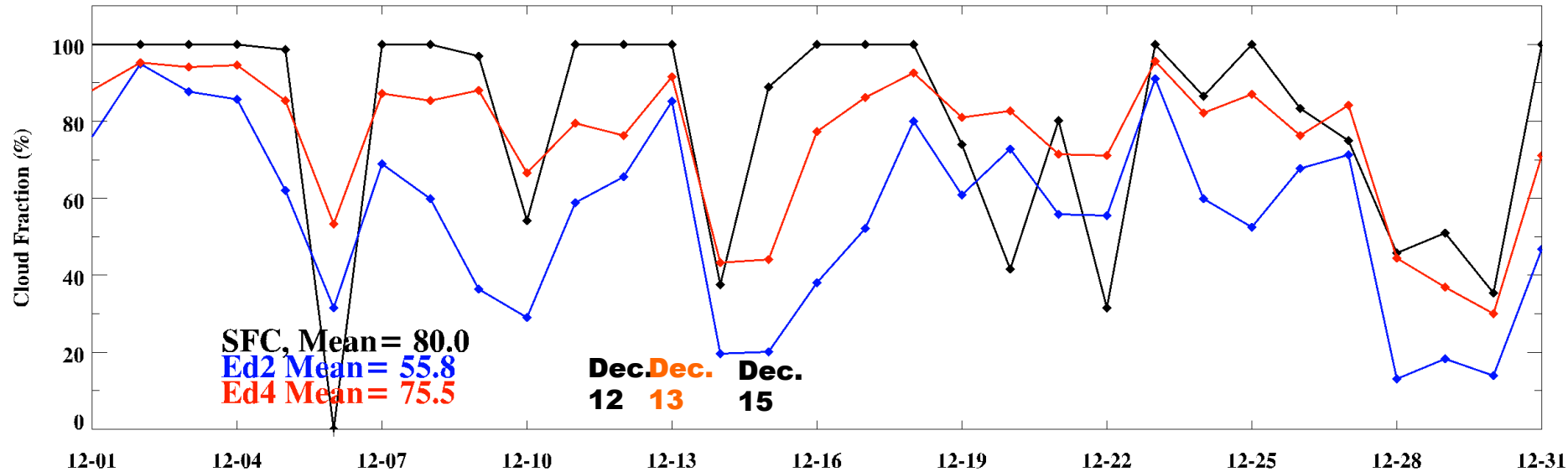
## Summary:

- For this deep clouds case, **Ed4** derived CFs increased to **87.6%** compared to **Ed2 52.6%**; closer to the **ground measurement 98.4%**

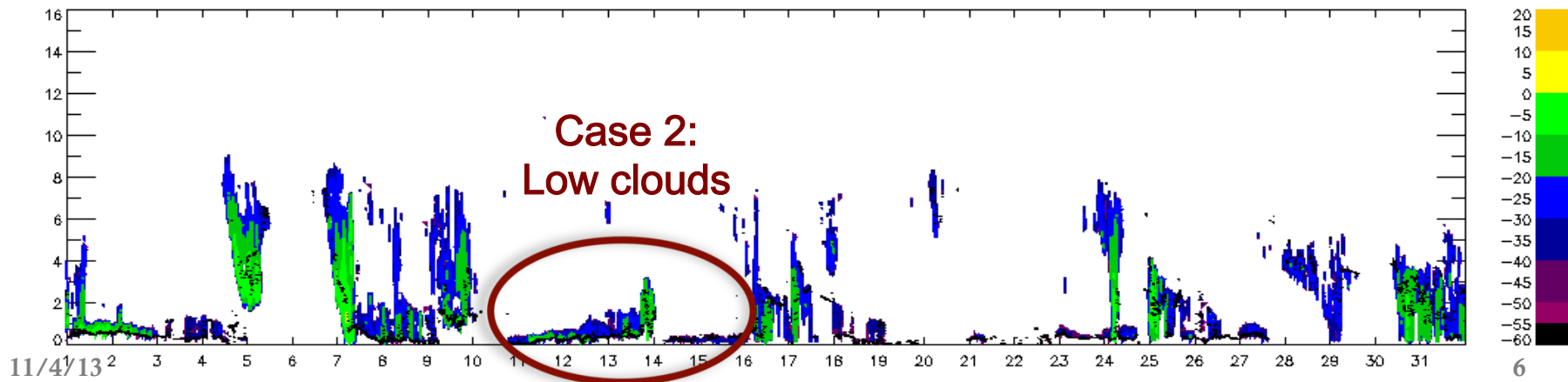


# Case 2: Low clouds, Dec. 11~16, 2002

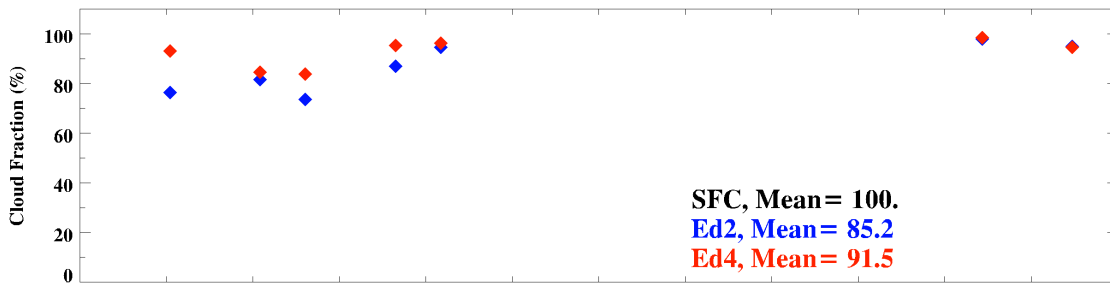
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200212



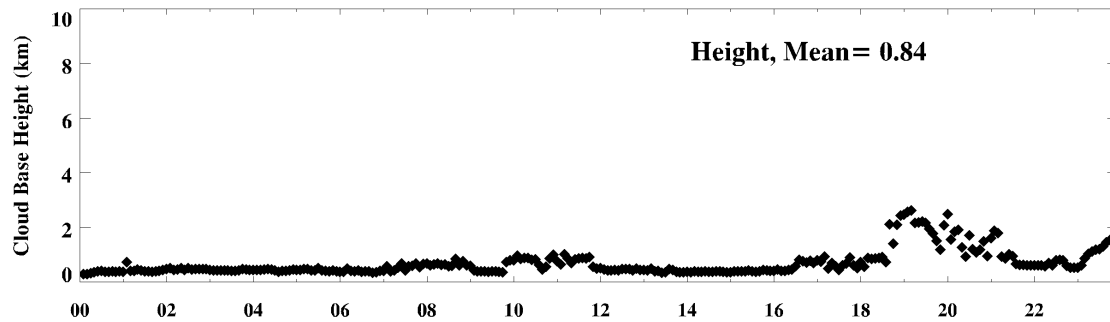
Radar Reflectivity from Surface Measurement for 200212



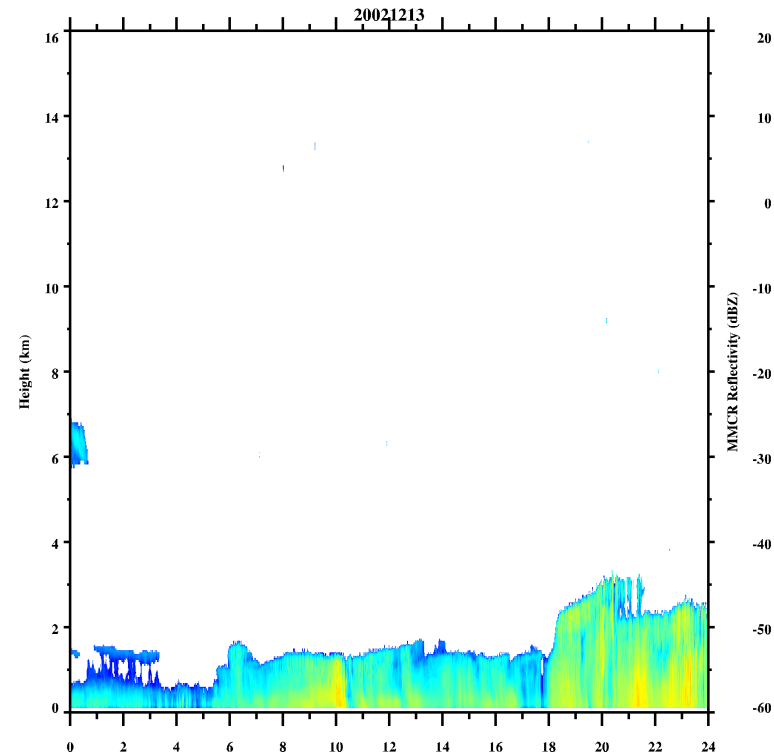
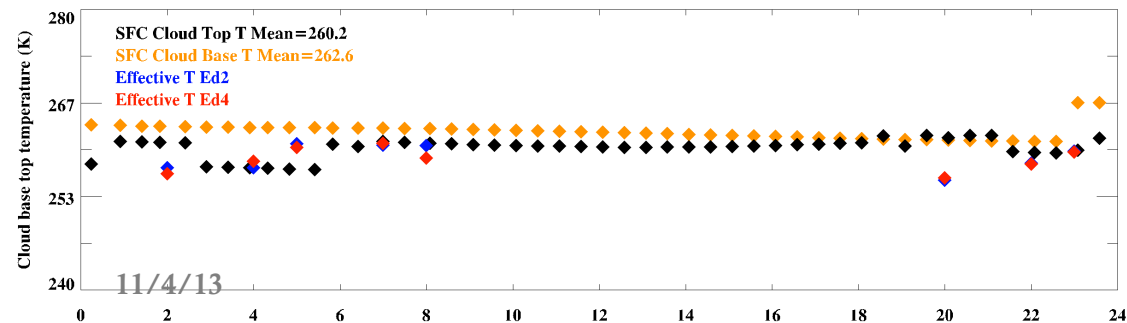
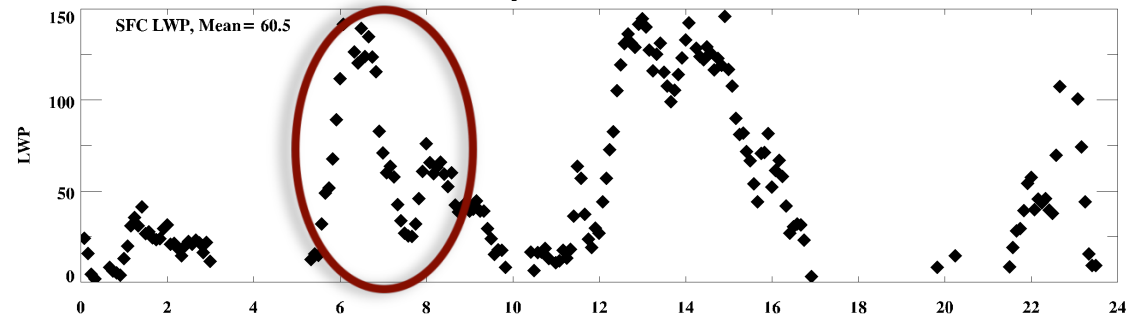
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 20021213



Cloud Base Height from Surface Measurement for 20021213

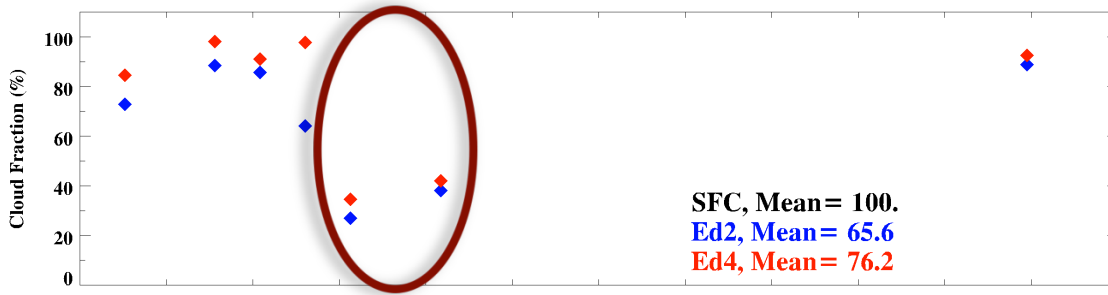


Cloud LWP and Temperature over Barrow NSA for 20021213

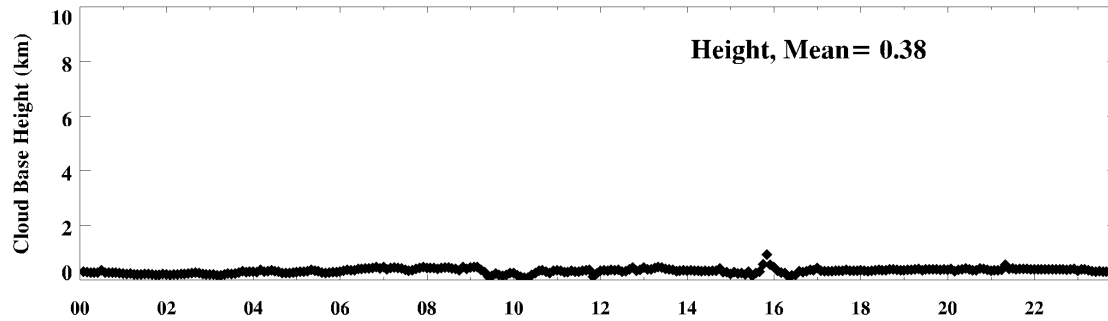


- Cloud top  $T = 260.2$  K,  
Cloud base  $T = 262.6$  K
- Cloud **LWPs** are large,  
CFs derived from both  
**Ed2** and **Ed4** agree well  
with **ARM** CFs.

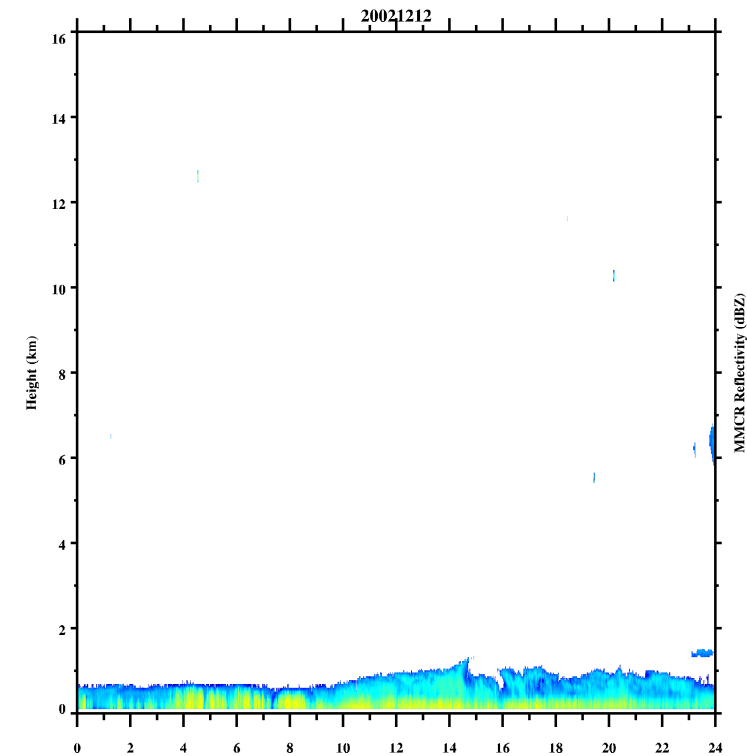
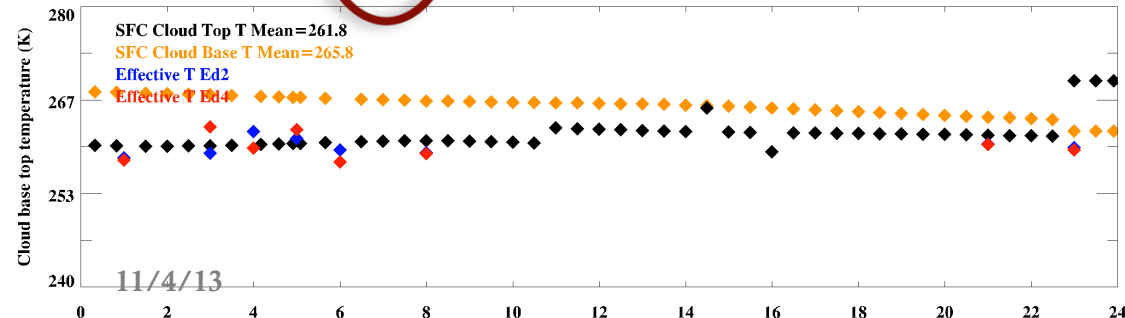
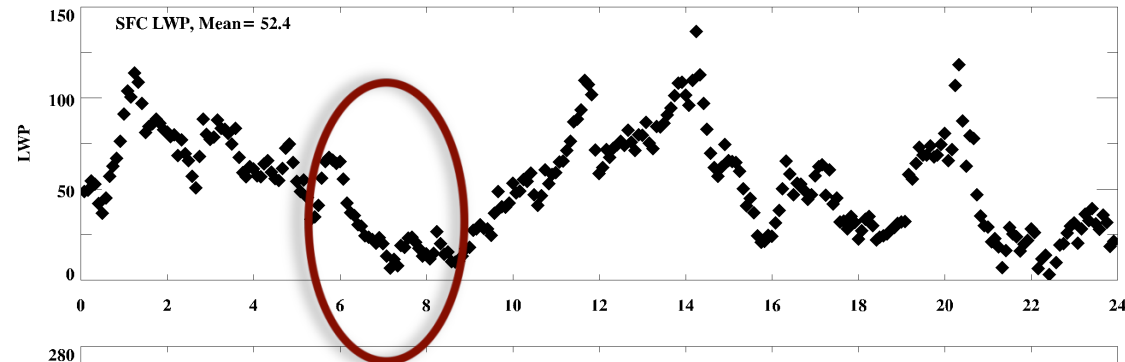
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 20021212



Cloud Base Height from Surface Measurement for 20021212

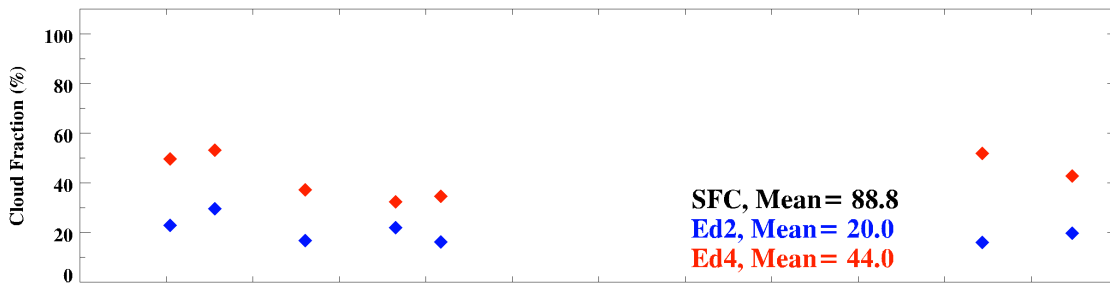


Cloud LWP and Temperature over Barrow NSA for 20021212

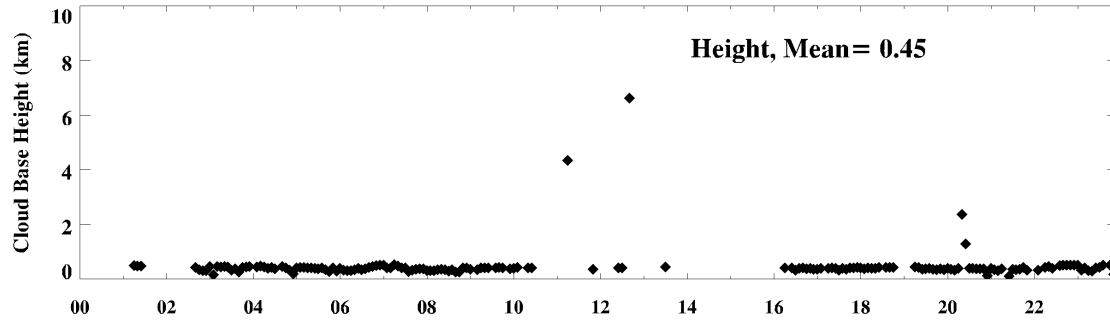


- Cloud top T = 261.8 K,  
Cloud base T = 265.8 K
- When LWP decreased  
from  $75 \text{ gm}^{-2}$  at 6Z to  $20 \text{ gm}^{-2}$  at 8Z, both Ed2 and Ed4 under-estimated cloud fraction

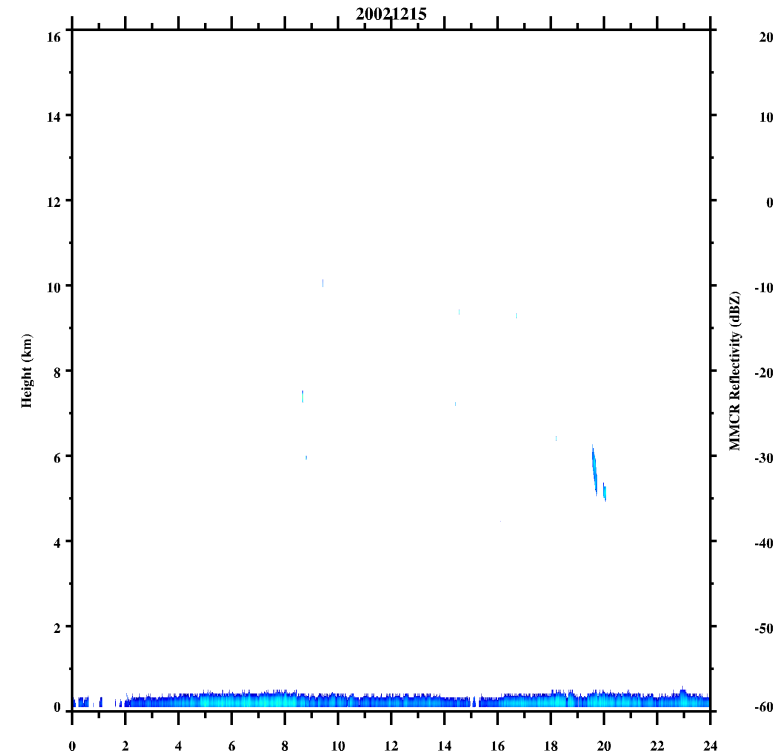
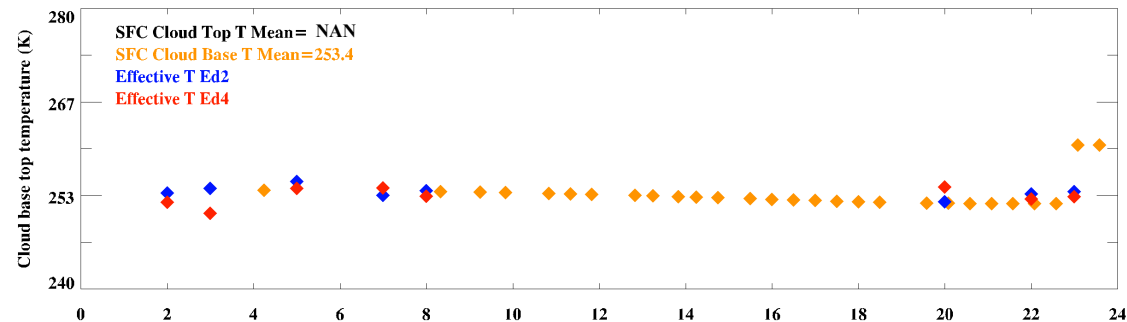
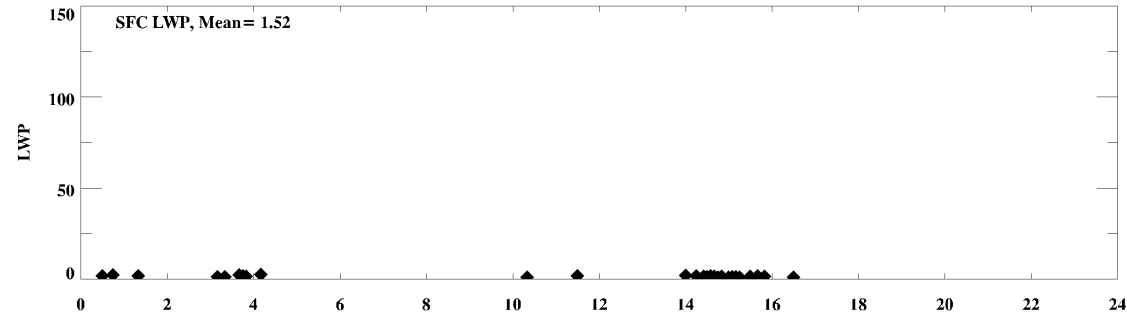
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 20021215



Cloud Base Height from Surface Measurement for 20021215

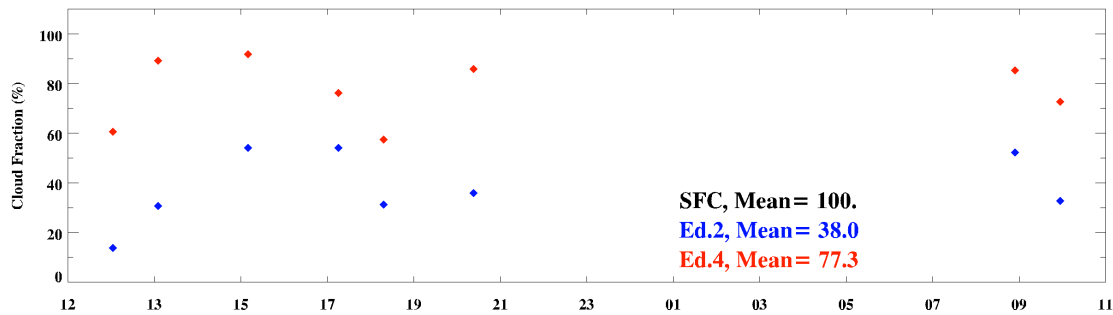


Cloud LWP and Temperature over Barrow NSA for 20021215

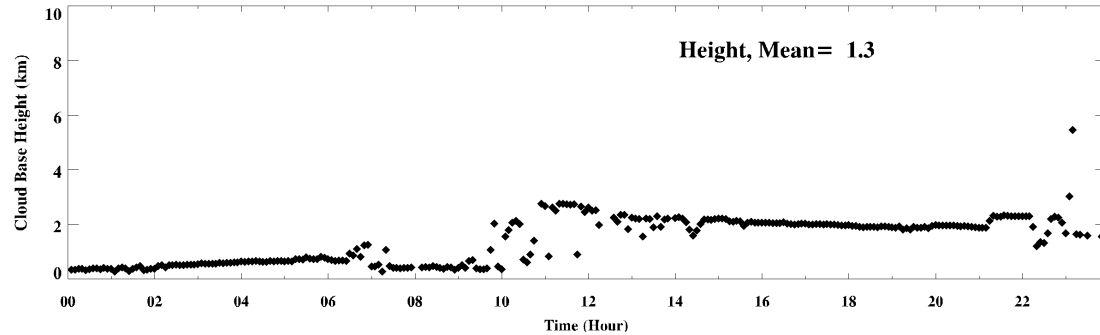


- Cloud base T = 253.4 K
- When LWPs are low, both Ed2 and Ed4 CFs are much lower than ARM CFs.
- Ed4 increased 24%

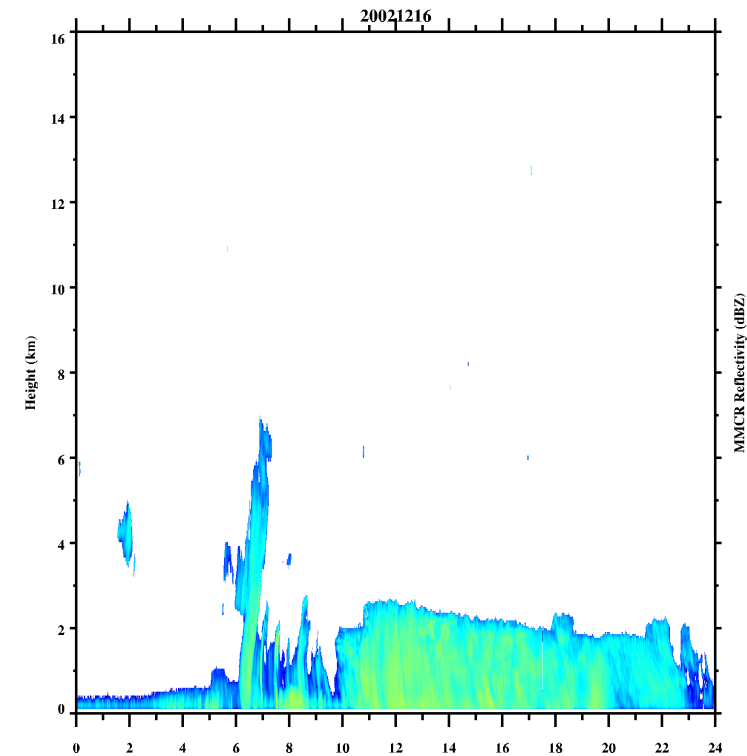
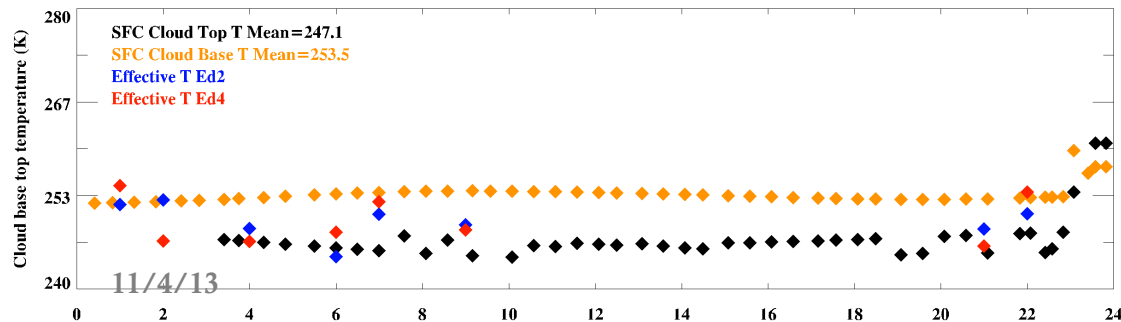
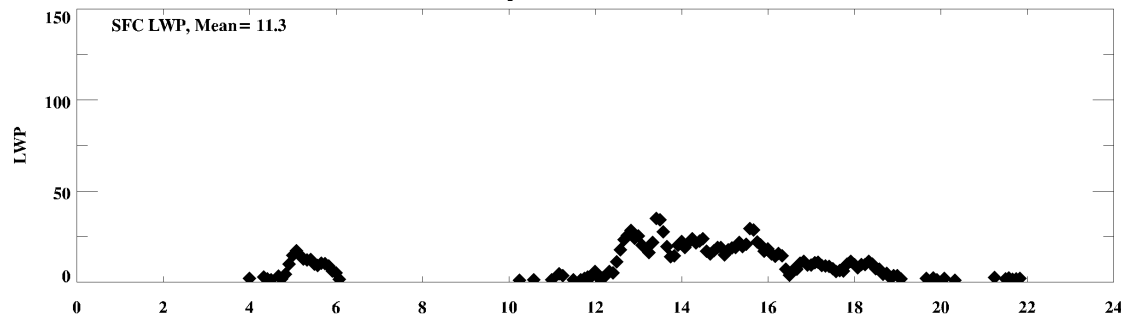
CERES ED.2 ED.4 Cloud Fraction over Barrow NSA for 20021216



Cloud Base Height from Surface Measurement for 20021216



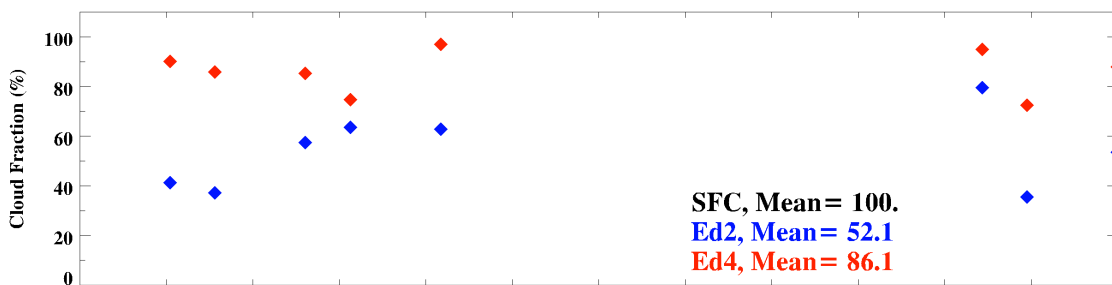
Cloud LWP and Temperature over Barrow NSA for 20021216



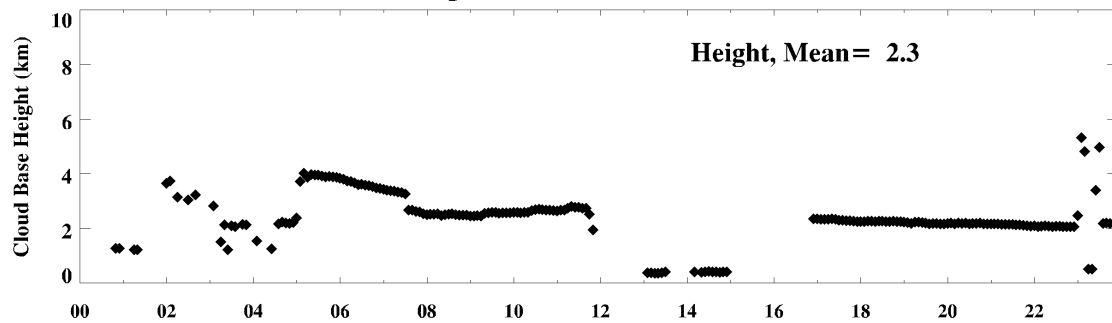
- Cloud top T = 247.1 K,  
Cloud base T = 253.5 K
- Low cloud LWP
- Ed2 underestimate CFs,  
38.0% Ed4 increased  
39% to 77%



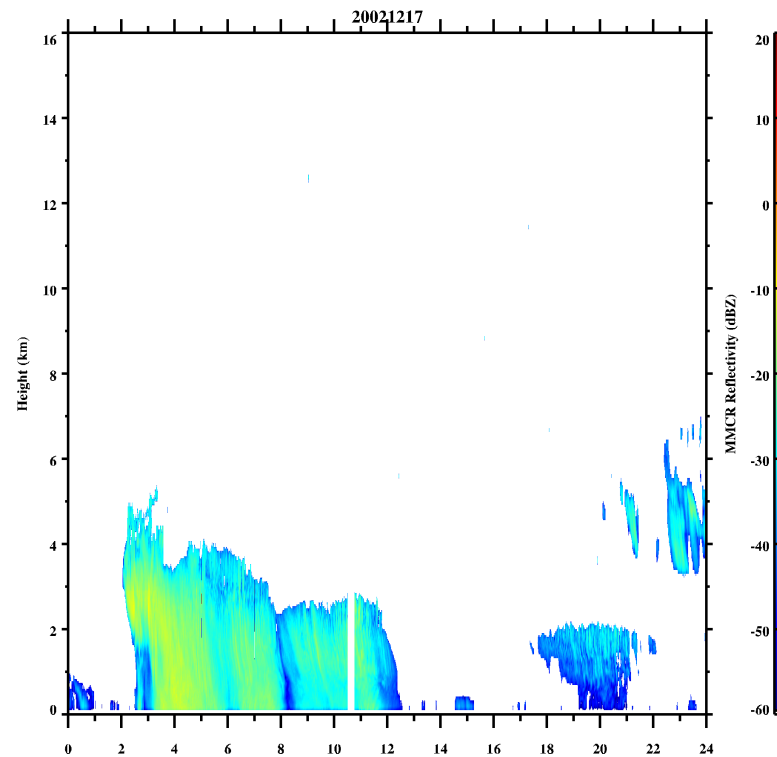
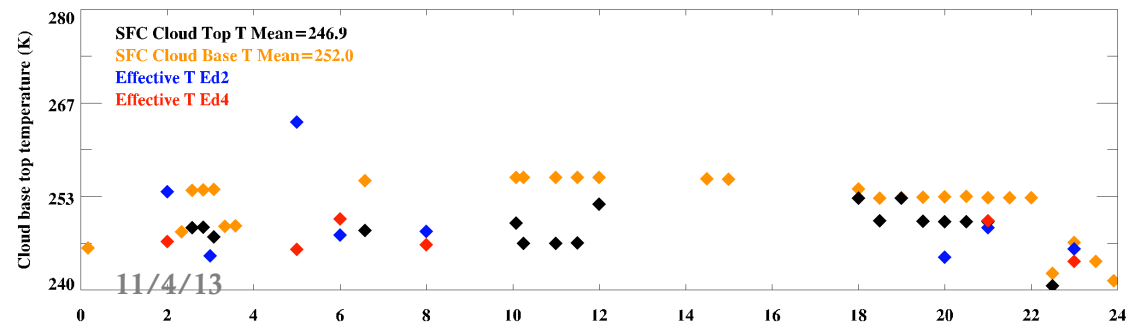
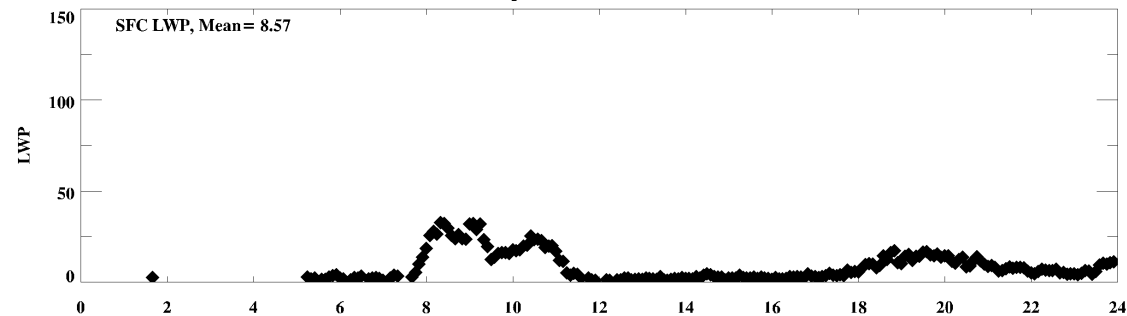
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 20021217



Cloud Base Height from Surface Measurement for 20021217



Cloud LWP and Temperature over Barrow NSA for 20021217



- Cloud top T = 246.9 K,  
Cloud base T = 252.0 K
- Cloud LWP low, <10 g/m<sup>2</sup>
- Ed4** improved 34% to 86%

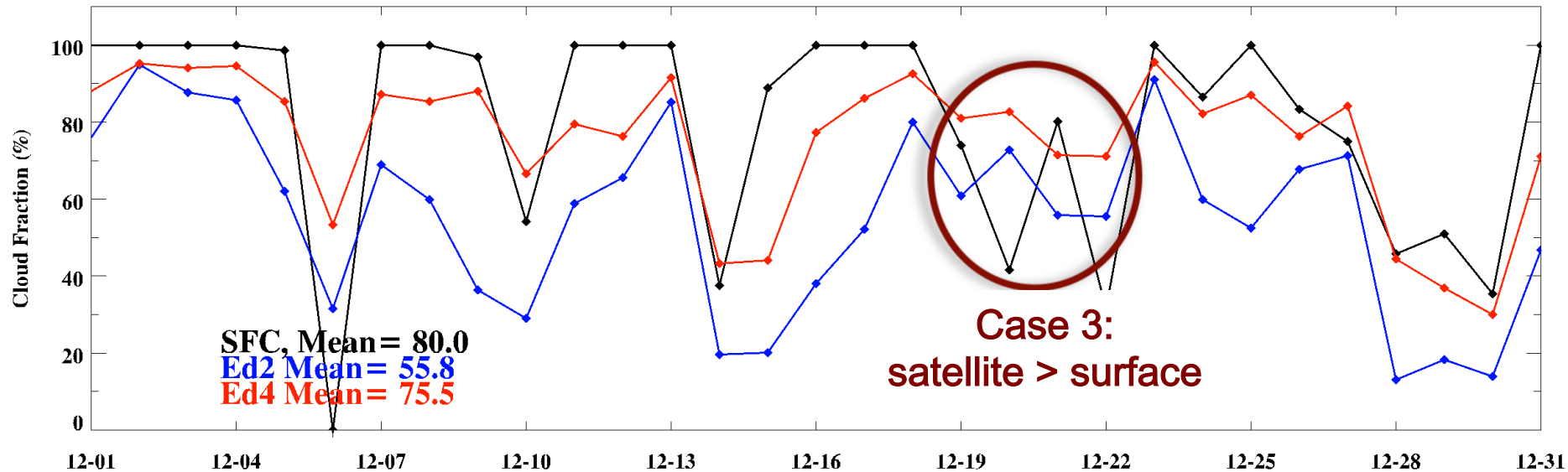
# Case 2: Low clouds, Dec. 11~16, 2002

## Summary for low clouds

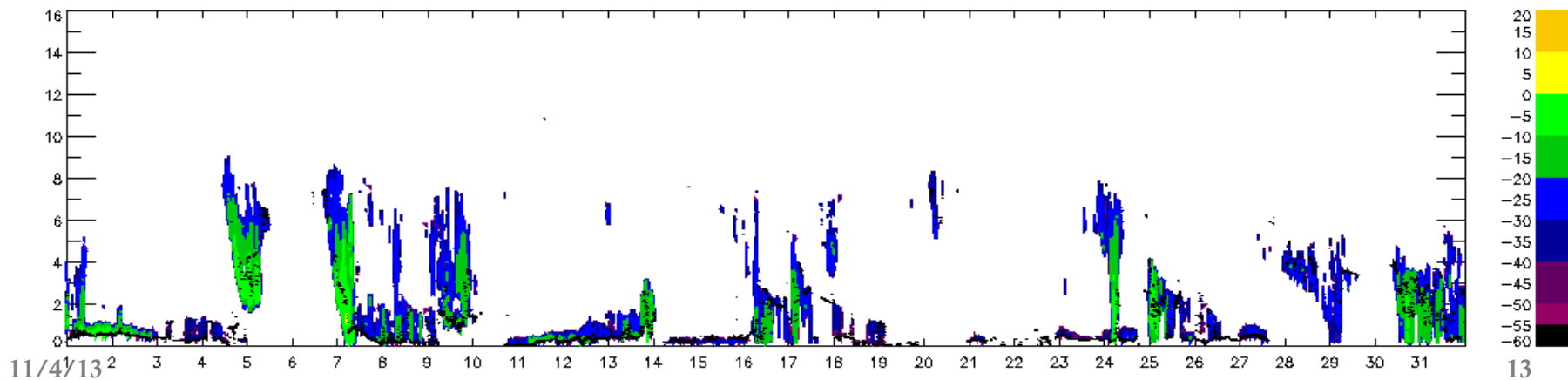
- When cloud LWP is large, **both Ed2 and Ed4 detected cloud fraction well.**
- When LWP is small and temperature difference between cloud top and ground is large, **big improvement from Ed4 to Ed2**
- When both Cloud LWP and temperature difference are small, both **Ed2 and Ed4 underestimate cloud fraction, but CF for Ed4 increased.**

# Case 3: CERES overestimated cloud fraction: Dec. 20~22, 2002

CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200212

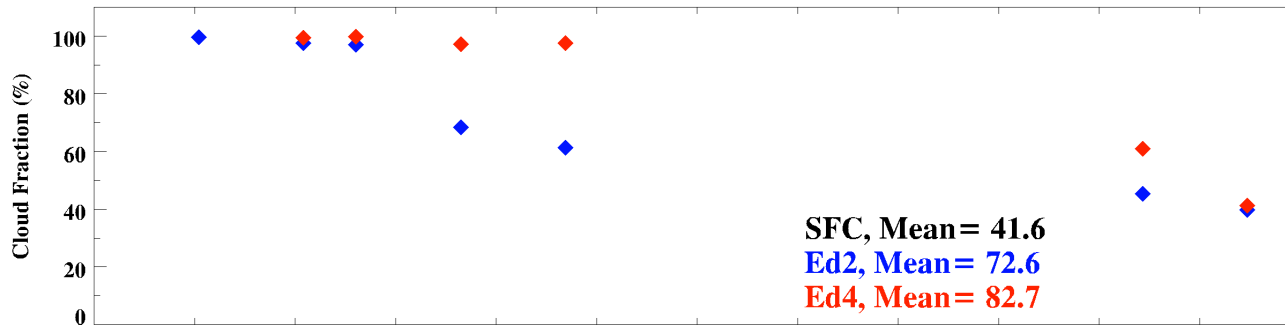


Radar Reflectivity from Surface Measurement for 200212

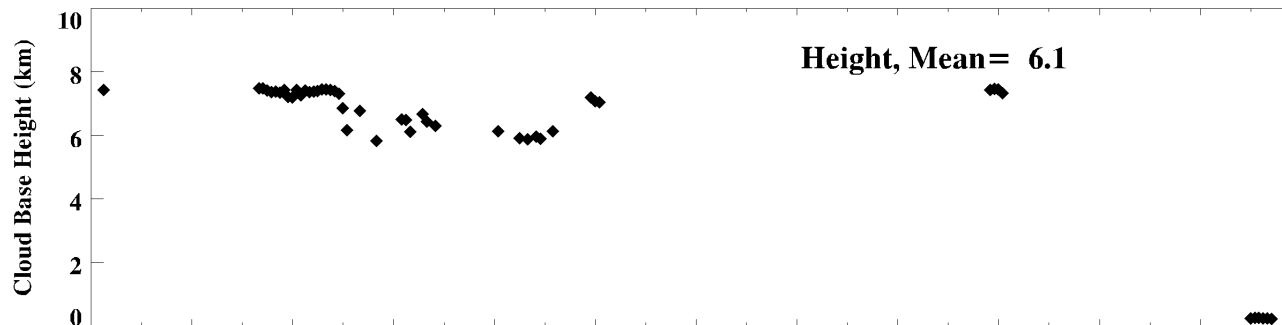


# Case 3: CERES overestimated cloud fraction: Dec. 20~22, 2002

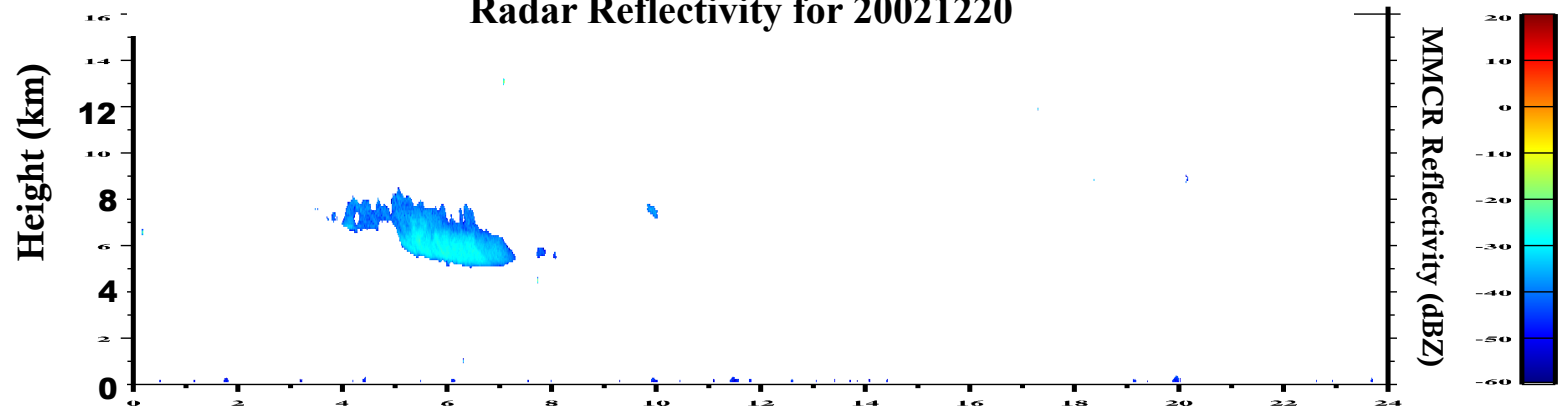
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 20021220



Cloud Base Height from Surface Measurement for 20021220

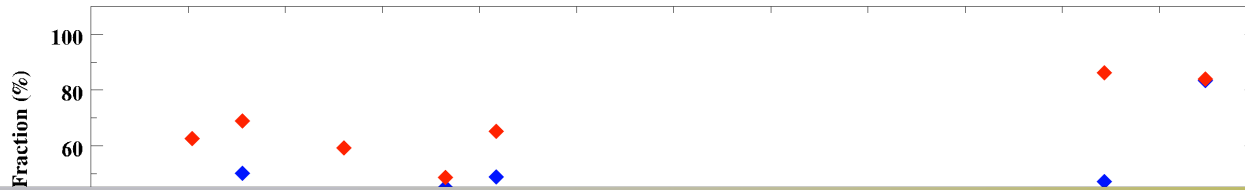


Radar Reflectivity for 20021220



# Case 3: CERES overestimated cloud fraction: Dec. 20~22, 2002

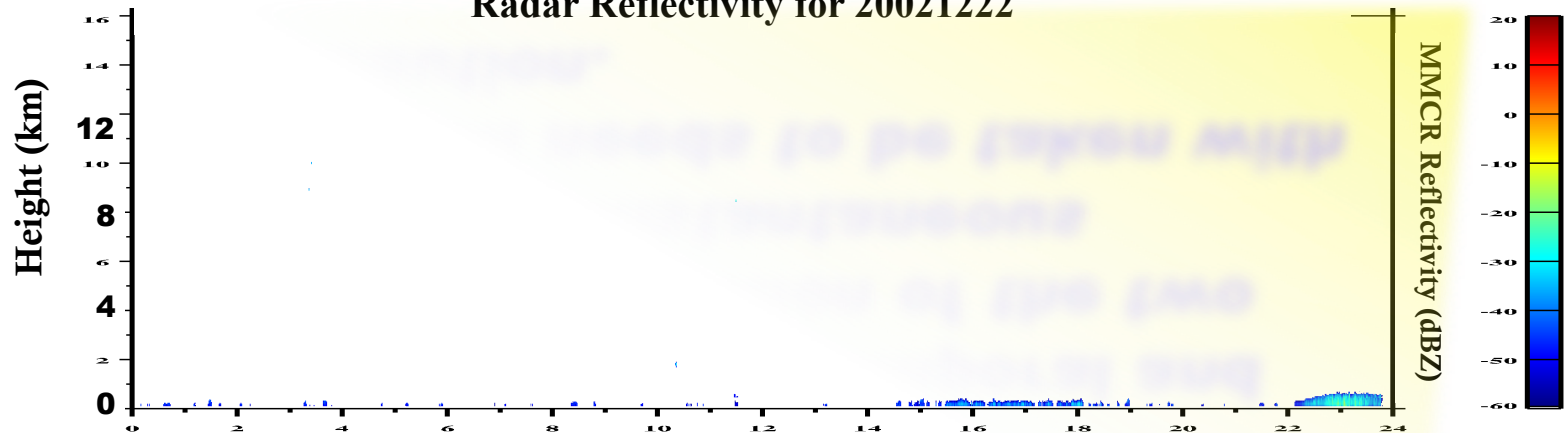
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 20021222



## Summary

- Due to the different temporal and spatial representation of the two datasets, the instantaneous comparison needs to be taken with extra caution.

Radar Reflectivity for 20021222



# Conclusion

- ◆ In general, CERES-MODIS **Ed4** derived **CFs** increased 20% compared to **Ed2** during Arctic Winter
- ◆ CERES **Ed4** can capture the **deep clouds** over snow/ice surfaces **better than Ed2**
- ◆ For Arctic winter low clouds,
  - ◆ When cloud LWP is large, both CERES-MODIS **Ed4** and **Ed2** can detect cloud amount well
  - ◆ When cloud LWP and temperature difference are low, **Ed2** and **Ed4** still underestimated low-level CFs, **but CFs for Ed4 increased.**

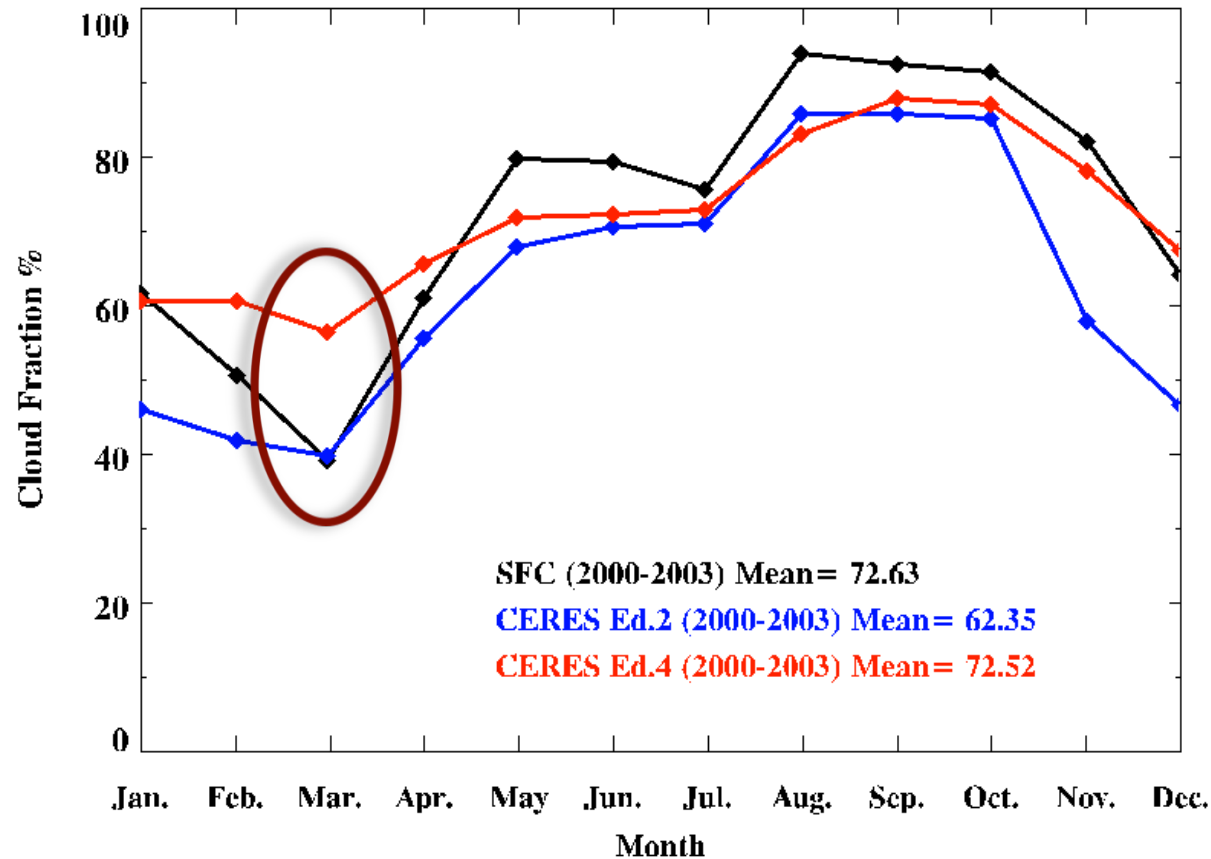


Thank you!

Questions?

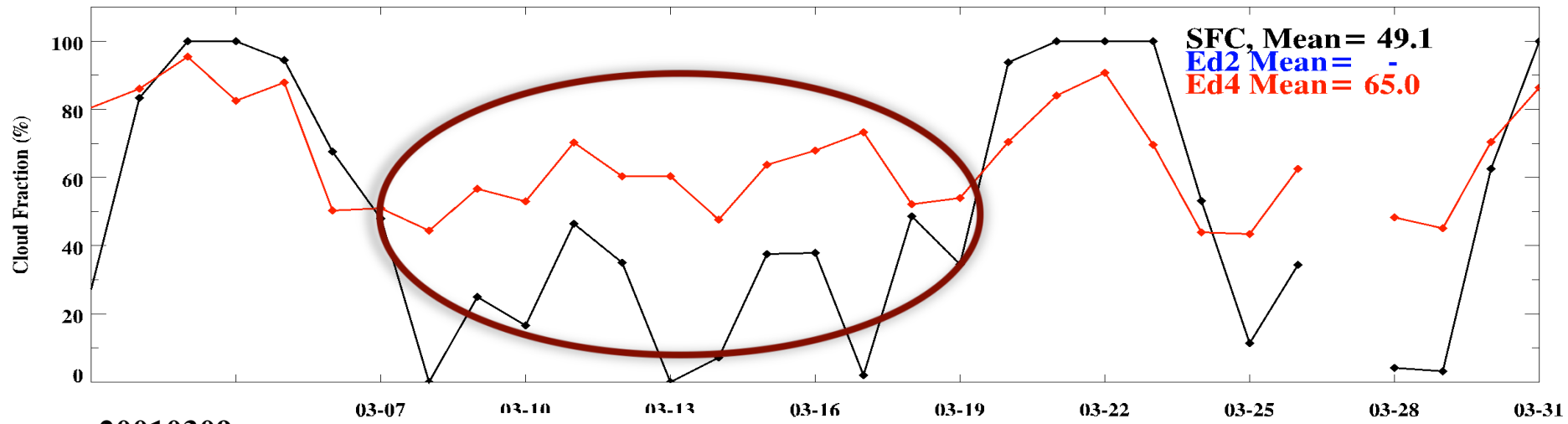


Climate Mean Cloud Fraction over Barrow, NSA



- March is also an interesting month:
- Lowest cloud fraction in the year
- Ed.4 overestimate CF of March while Ed.2 underestimate CF of March

# CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200103



20010309

20010310

20010311

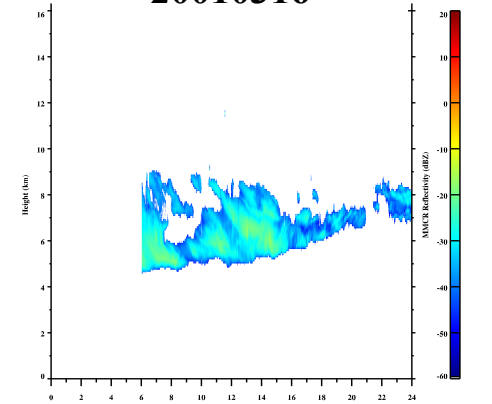
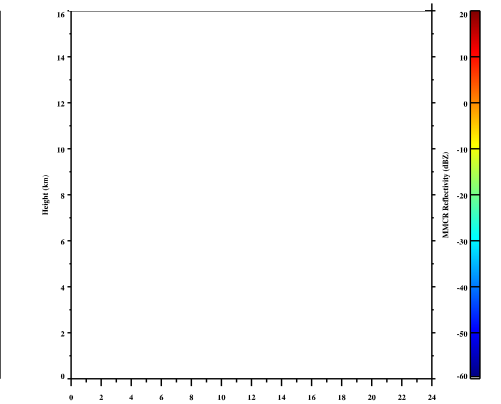
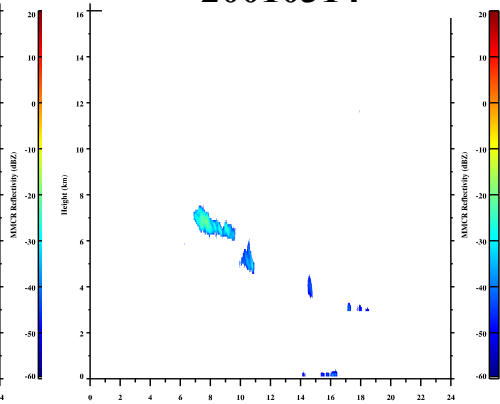
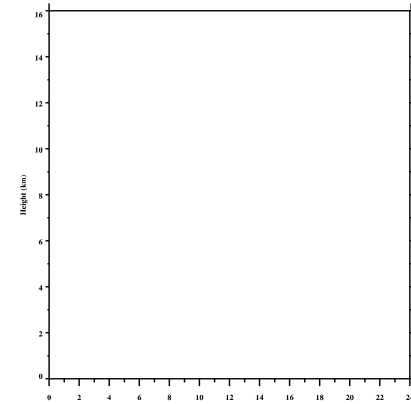
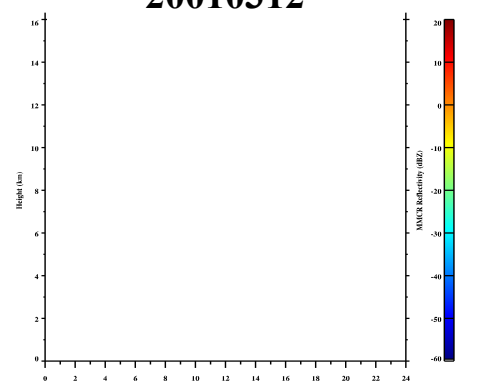
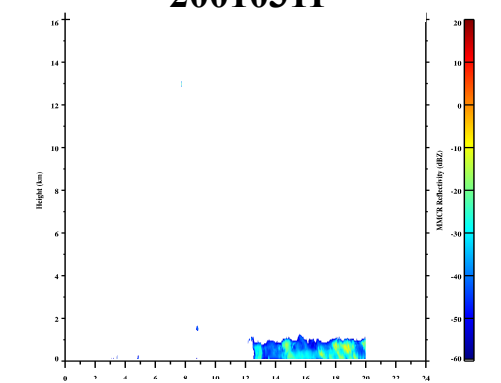
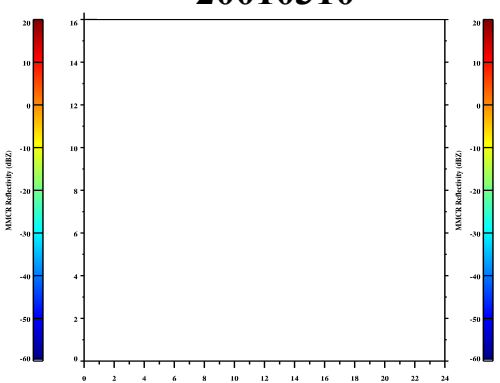
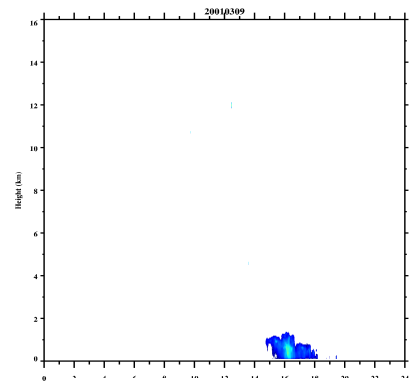
20010312

20010313

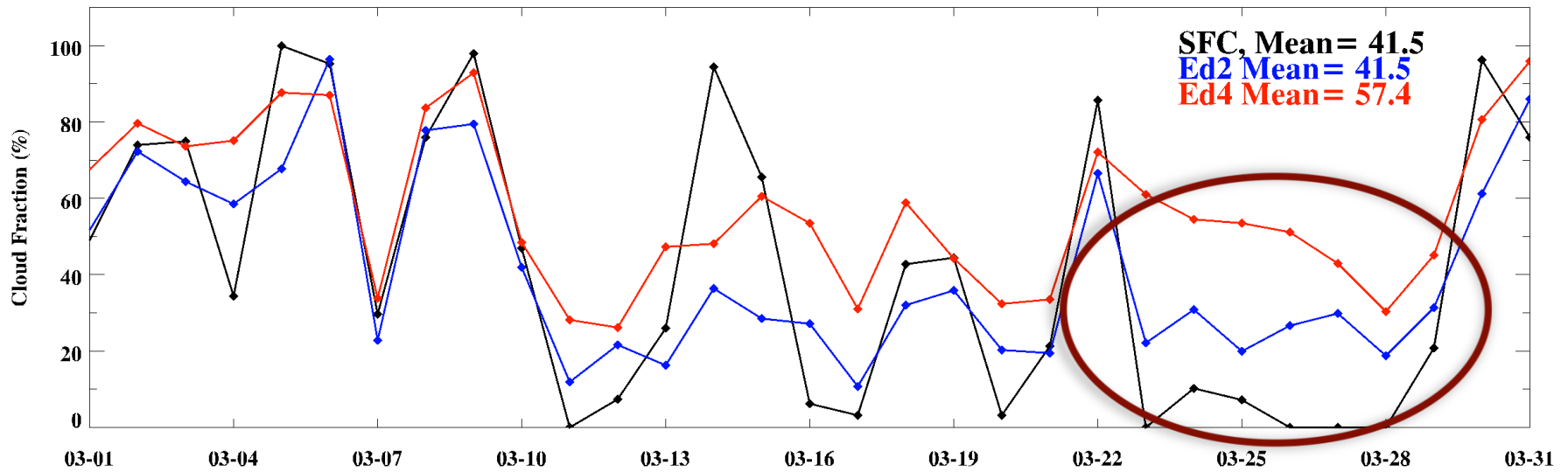
20010314

20010315

20010316



# CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200303

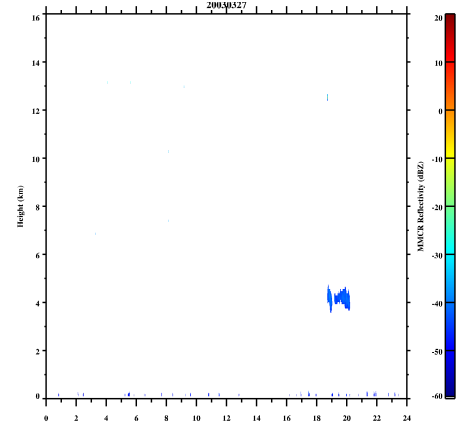
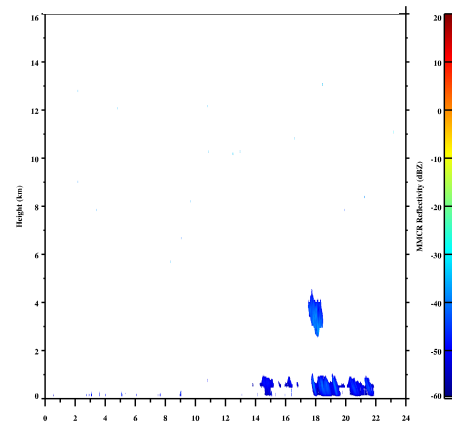
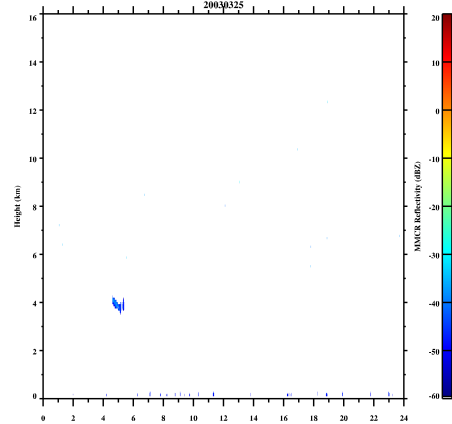
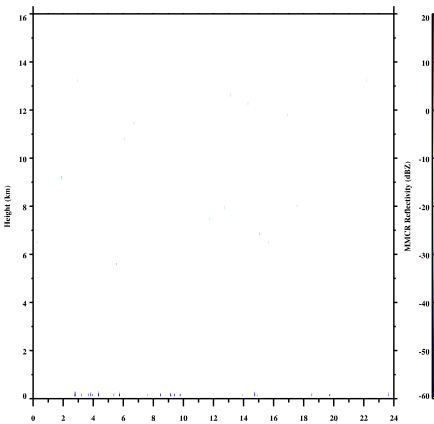


20030324

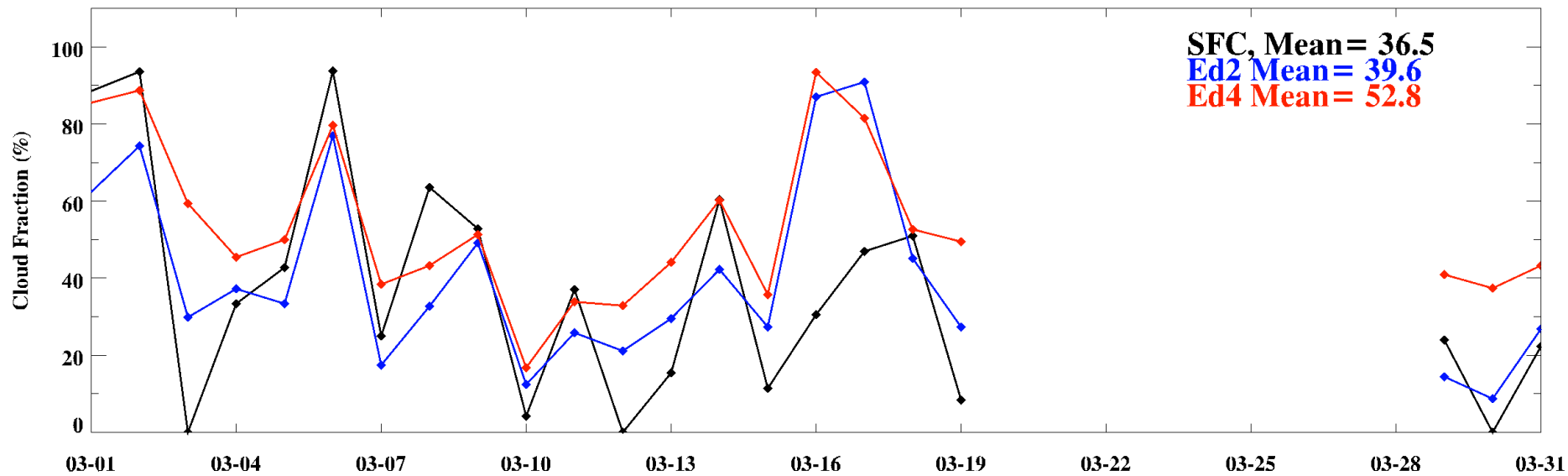
20030325

20030326

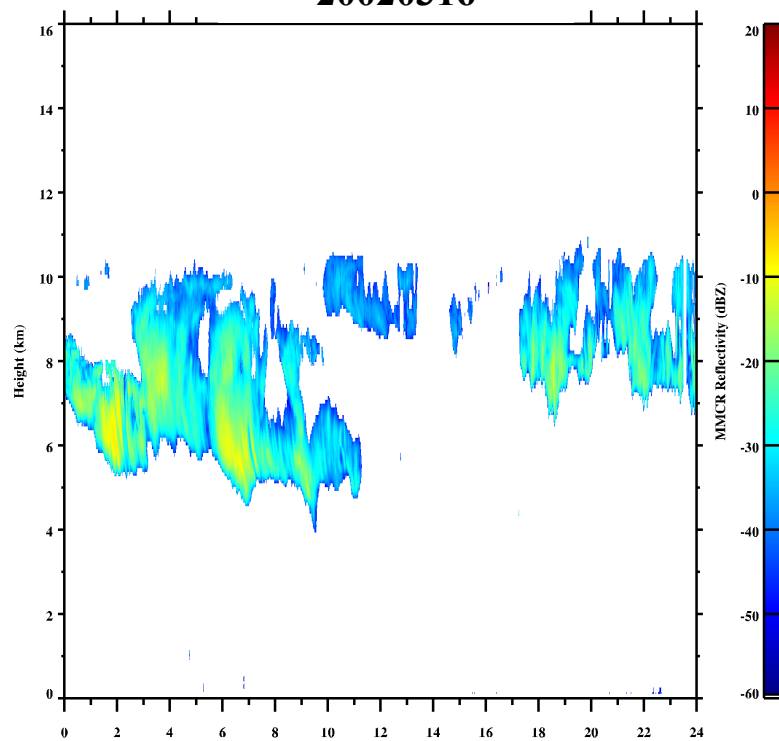
20030327



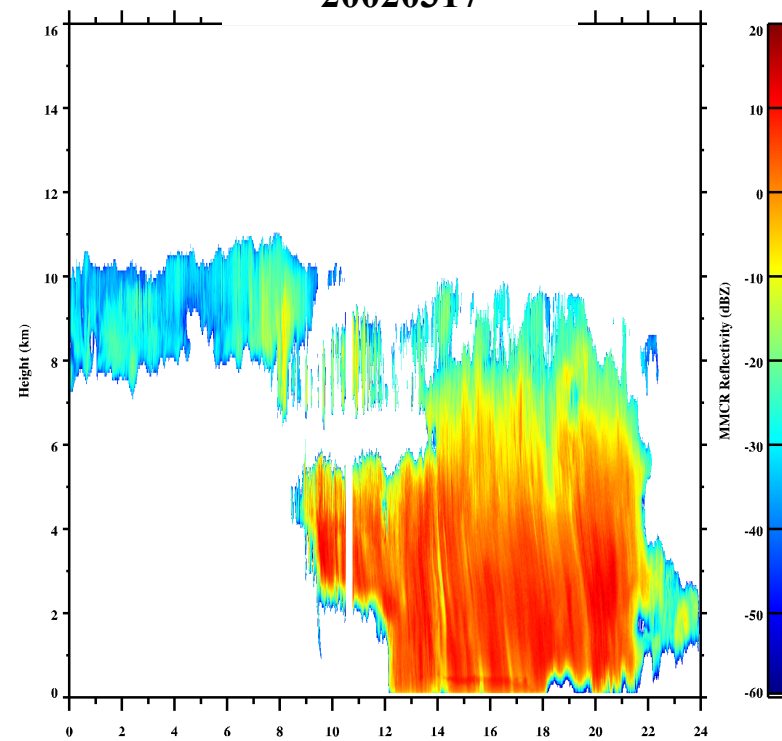
# CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200203



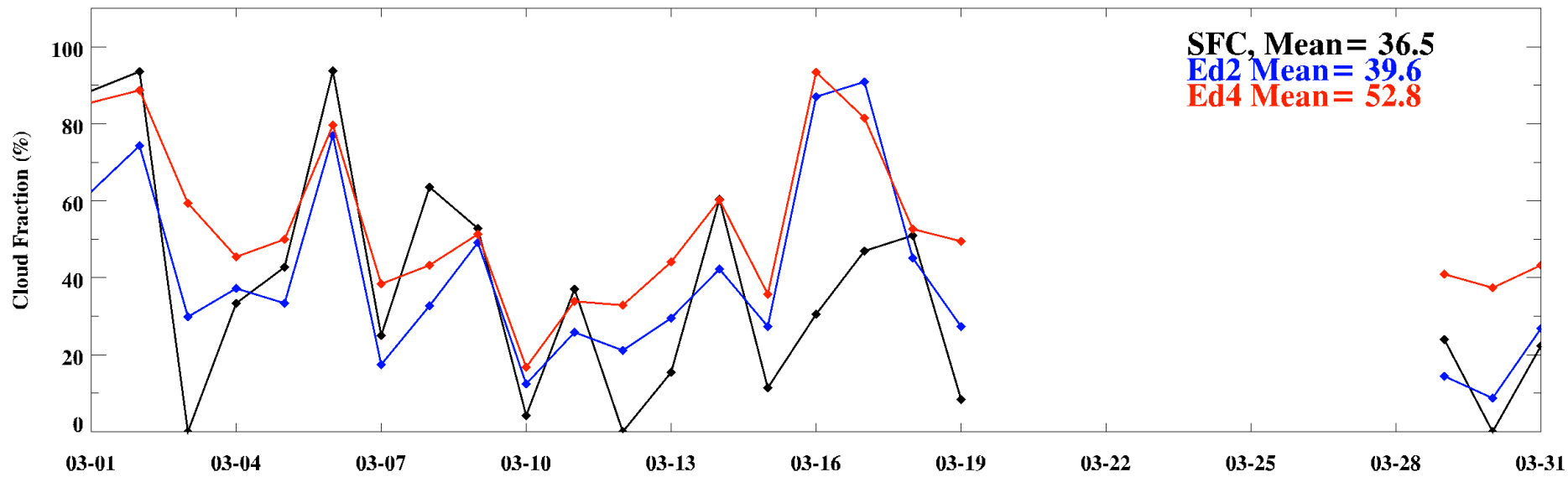
20020316



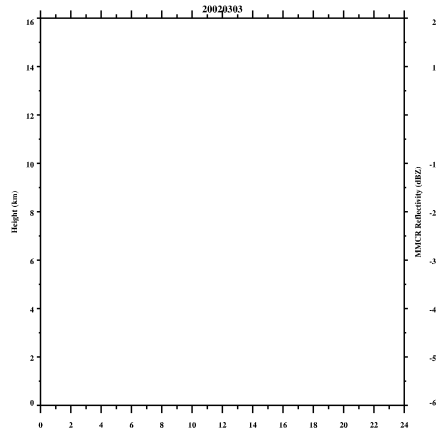
20020317



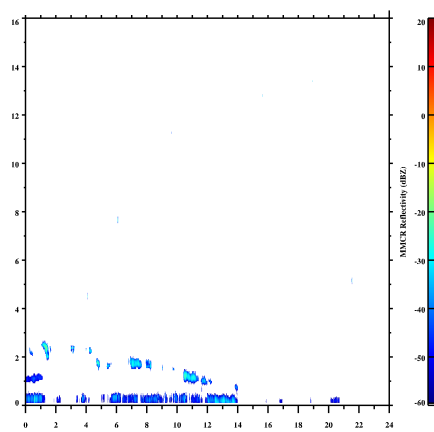
# CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200203



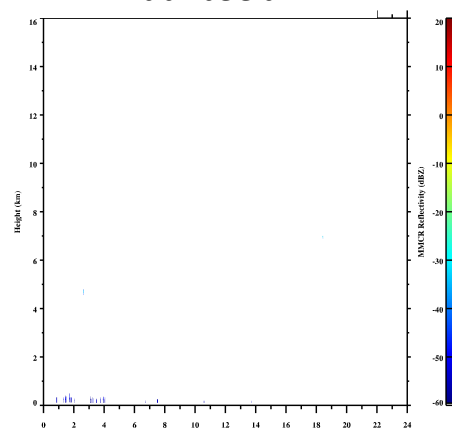
20030303



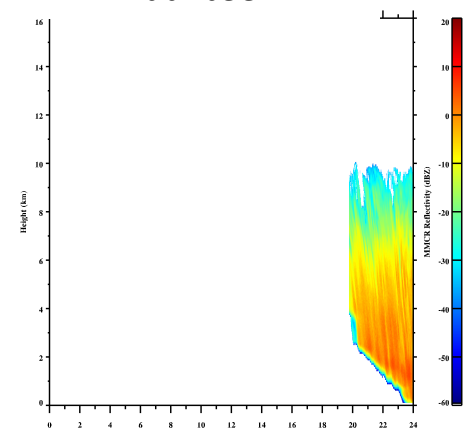
20020329



20020330

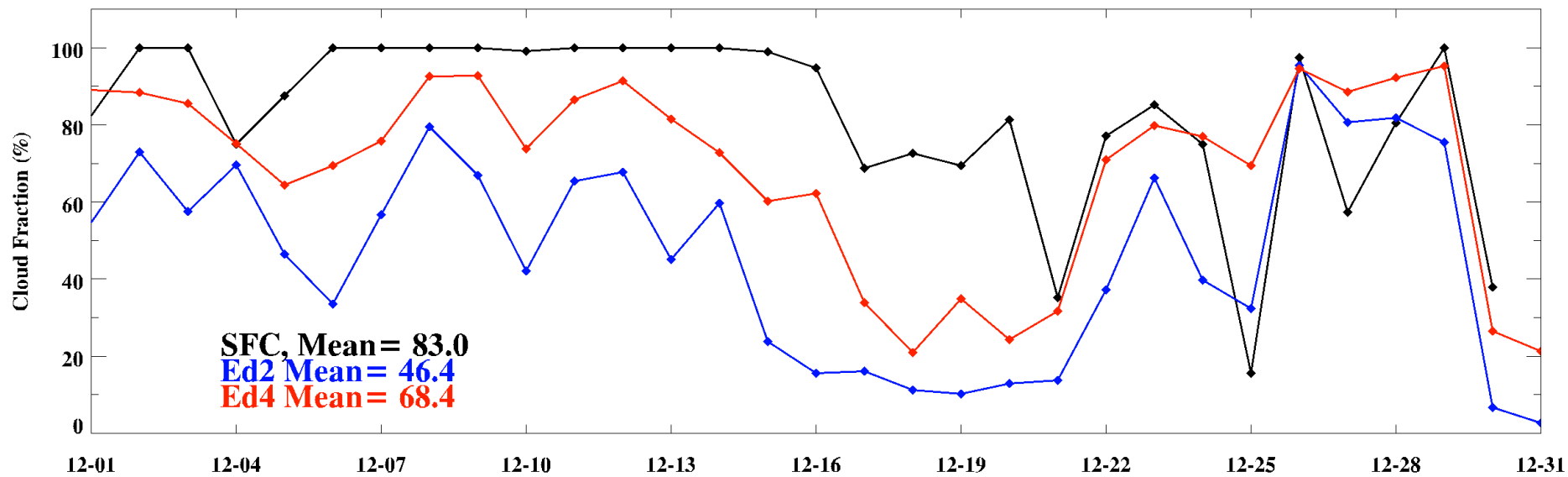


20020331

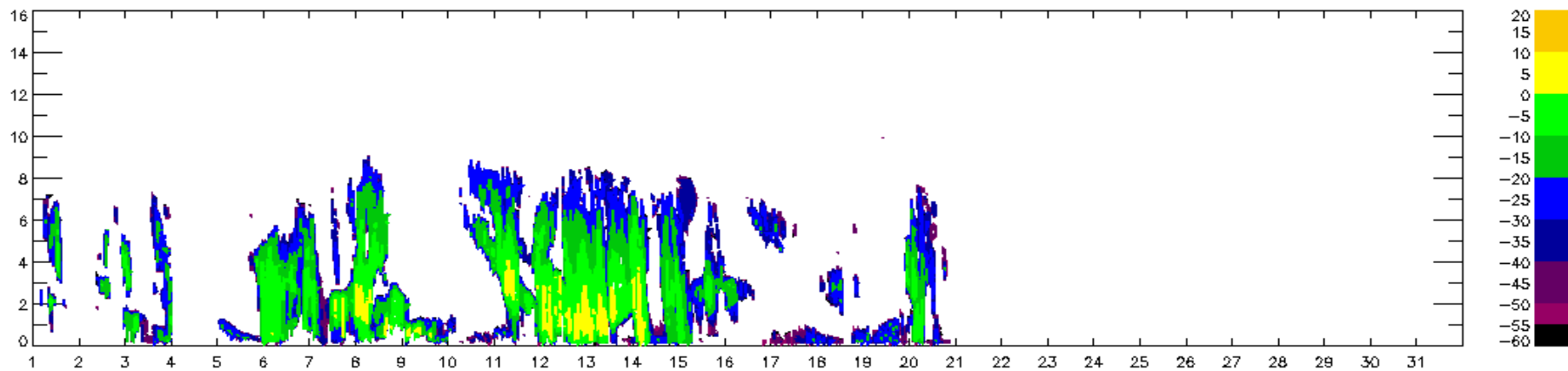




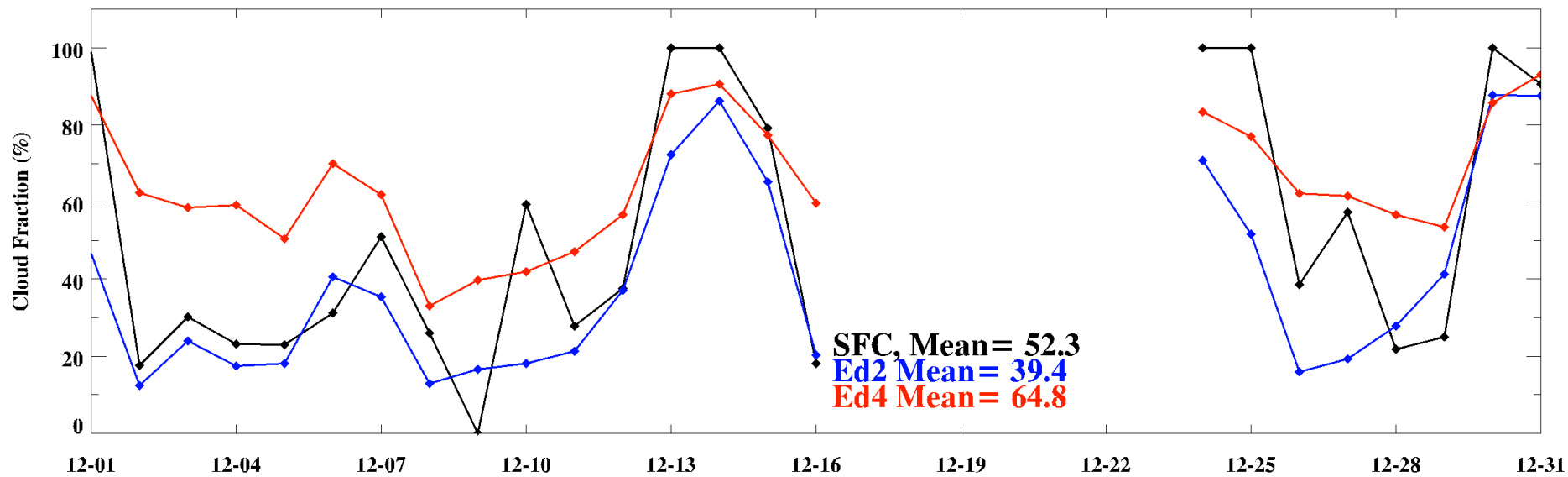
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200112



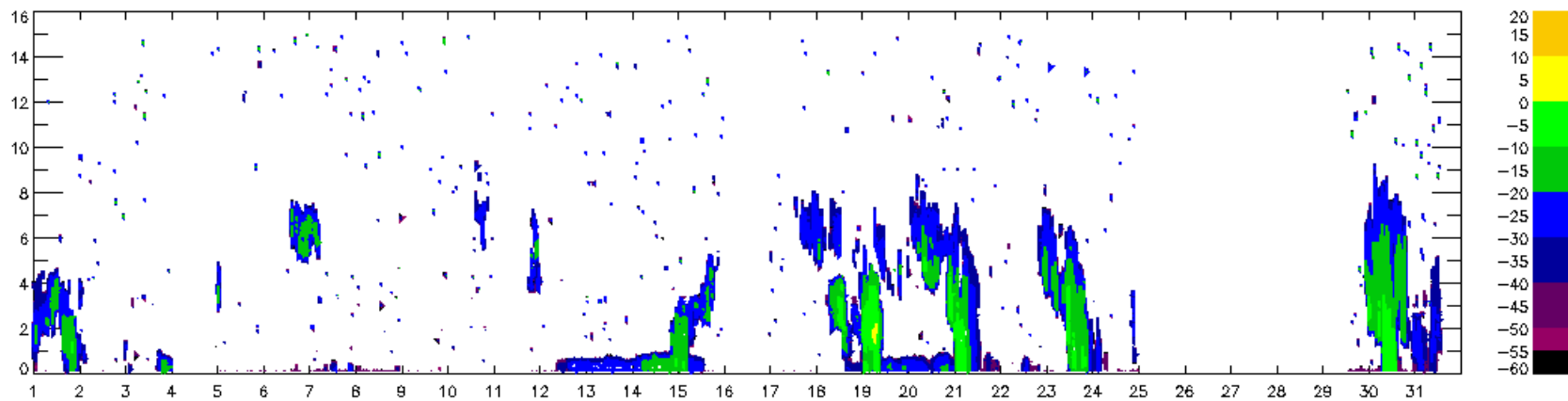
Radar Reflectivity from Surface Measurement for 200112



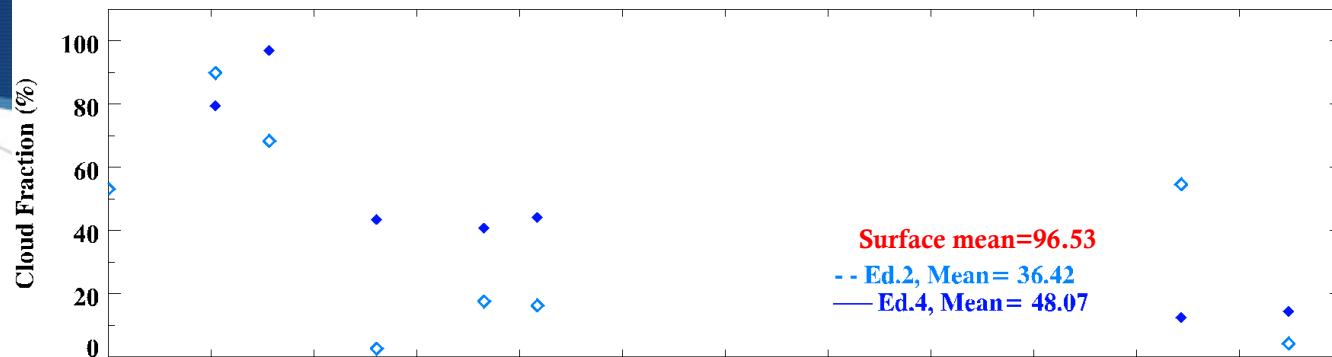
CERES Ed2 Ed4 Cloud Fraction over Barrow NSA for 200312



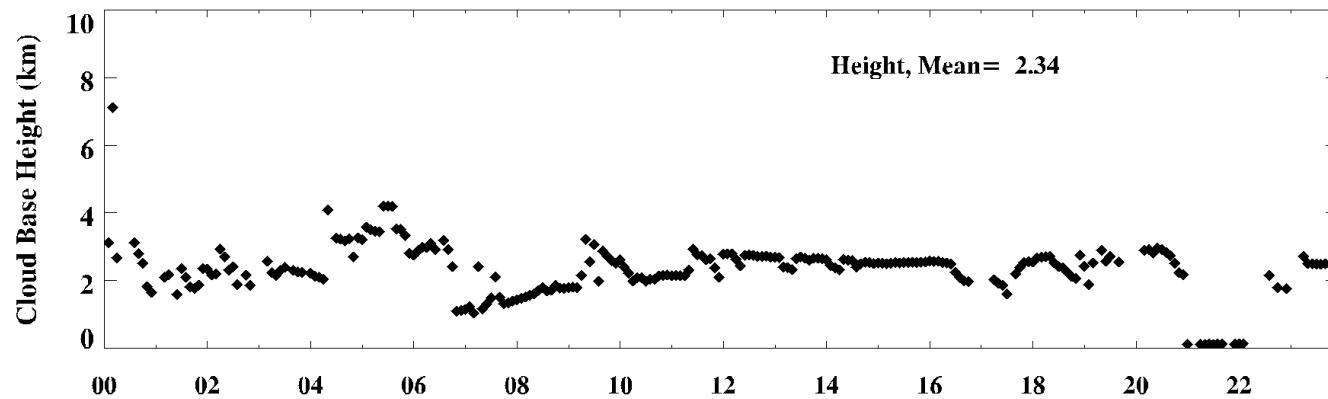
Radar Reflectivity from Surface Measurement for 200312



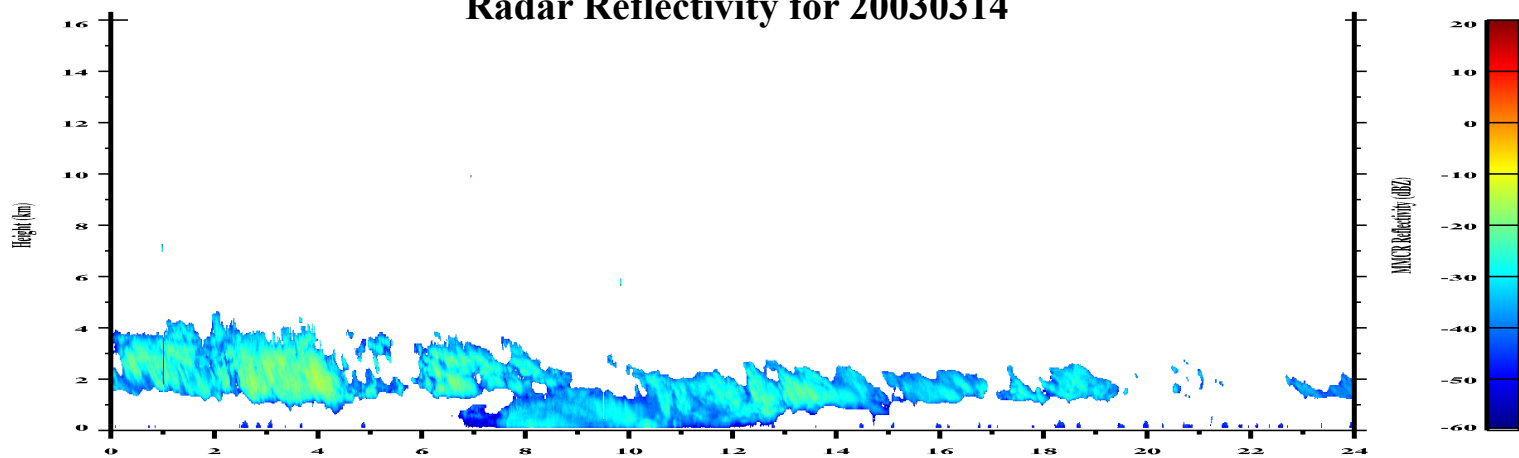
**CERES ED.2 ED.4 Cloud Fraction over Barrow NSA for 20030314**



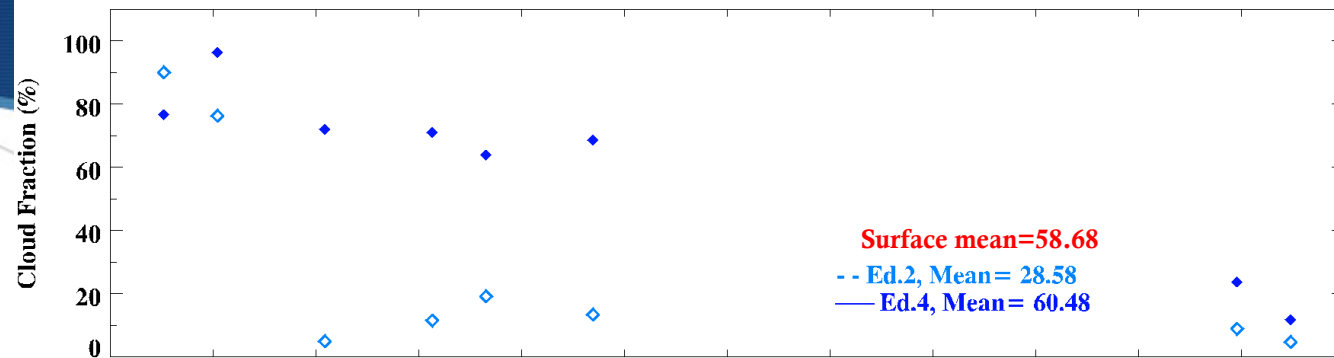
**Cloud Base Height from Surface Measurement for 20030314**



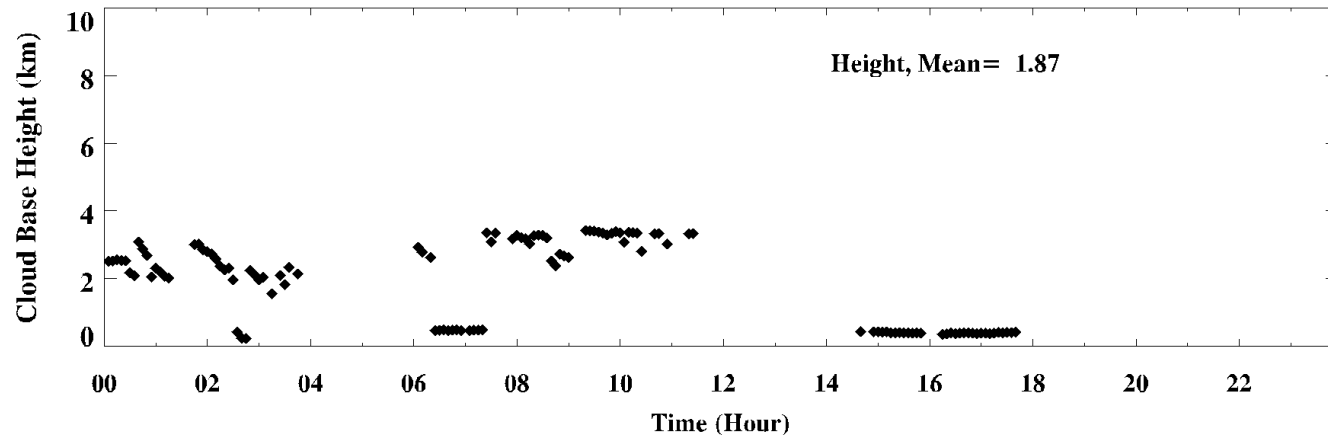
**Radar Reflectivity for 20030314**



CERES ED.2 ED.4 Cloud Fraction over Barrow NSA for 20030315



Cloud Base Height from Surface Measurement for 20030315



Radar Reflectivity for 20030315

